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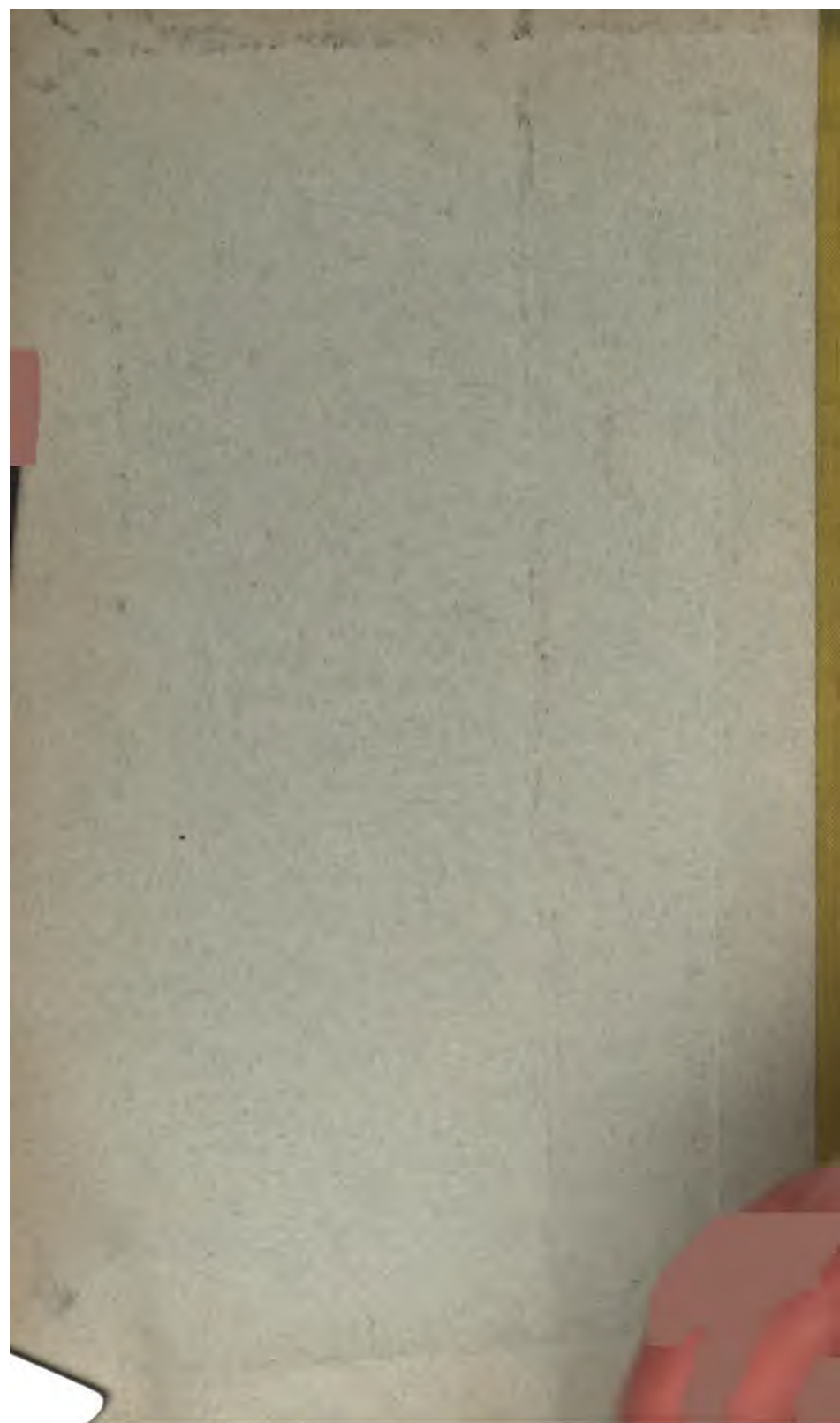
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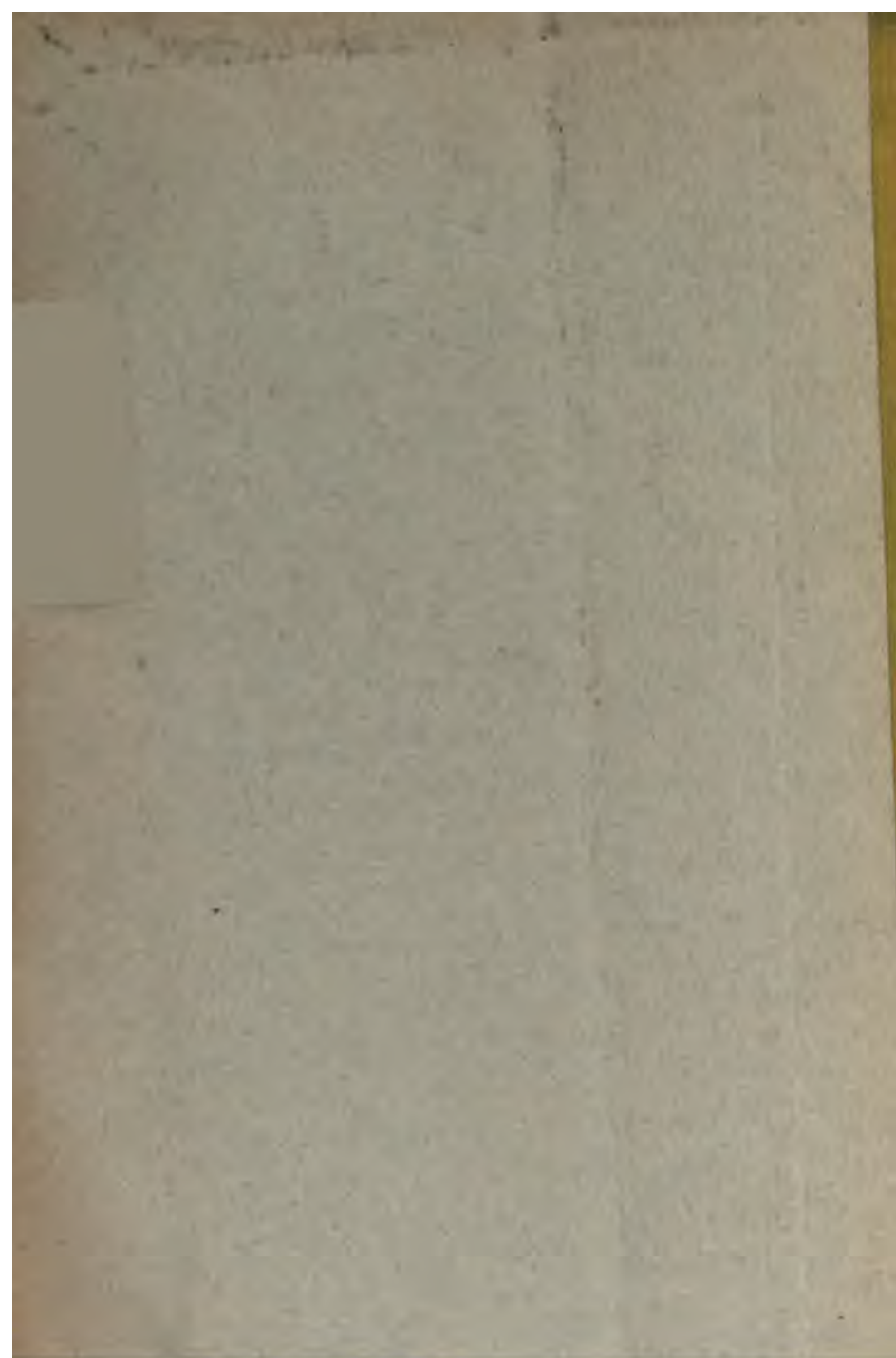


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TENTH  
ANNUAL REPORT  
OF THE  
★  
LOWELL WATER BOARD  
TO THE CITY COUNCIL,

ACCOMPANIED BY THE REPORTS OF THE CITY ENGINEER AND OF THE  
SUPERINTENDENT OF WATER WORKS, TO THE WATER BOARD.

JANUARY 9, 1883.



LOWELL, MASS.:  
CORRIER PRESS: MARDEN & ROWELL,  
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## CITY OF LOWELL.

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IN WATER BOARD, January 9, 1883.

Read and accepted, and ordered to be transmitted to the City Council.

Attest.

JAMES M. BATTLES, *Clerk.*

---

IN COMMON COUNCIL, January 9, 1883.

Read, and sent to the Board of Aldermen.

DAVID CHASE, *Clerk.*

---

IN BOARD OF ALDERMEN, January 9, 1883.

Received and read.

DAVID W. O'BRIEN, *City Clerk.*

## WATER BOARD, 1883.

---

*President* . . . . . ALBERT A. HAGGETT.

Term expires first Monday in May, 1883.

CHARLES C. HUTCHINSON.

Term expires first Monday in May, 1884.

Alderman GEORGE W. FIFIELD.

Councilman EDWARD B. PEIRCE.      Councilman JOHN J. HOGAN.

*Clerk* . . . . . JAMES M. BATTLES.

Regular meetings of the Water Board, Friday evenings, at 7 1-2 o'clock.

*Superintendent of Works* . . . . . HORACE G. HOLDEN.

*Foreman of Works* . . . . . DANIEL D. FRASER.

*Engineer at Pumping Station* . . . . . JAMES P. ROBERTS.

*Service Clerk* . . . . . LEONARD T. FARRIS.

### *Inspectors.*

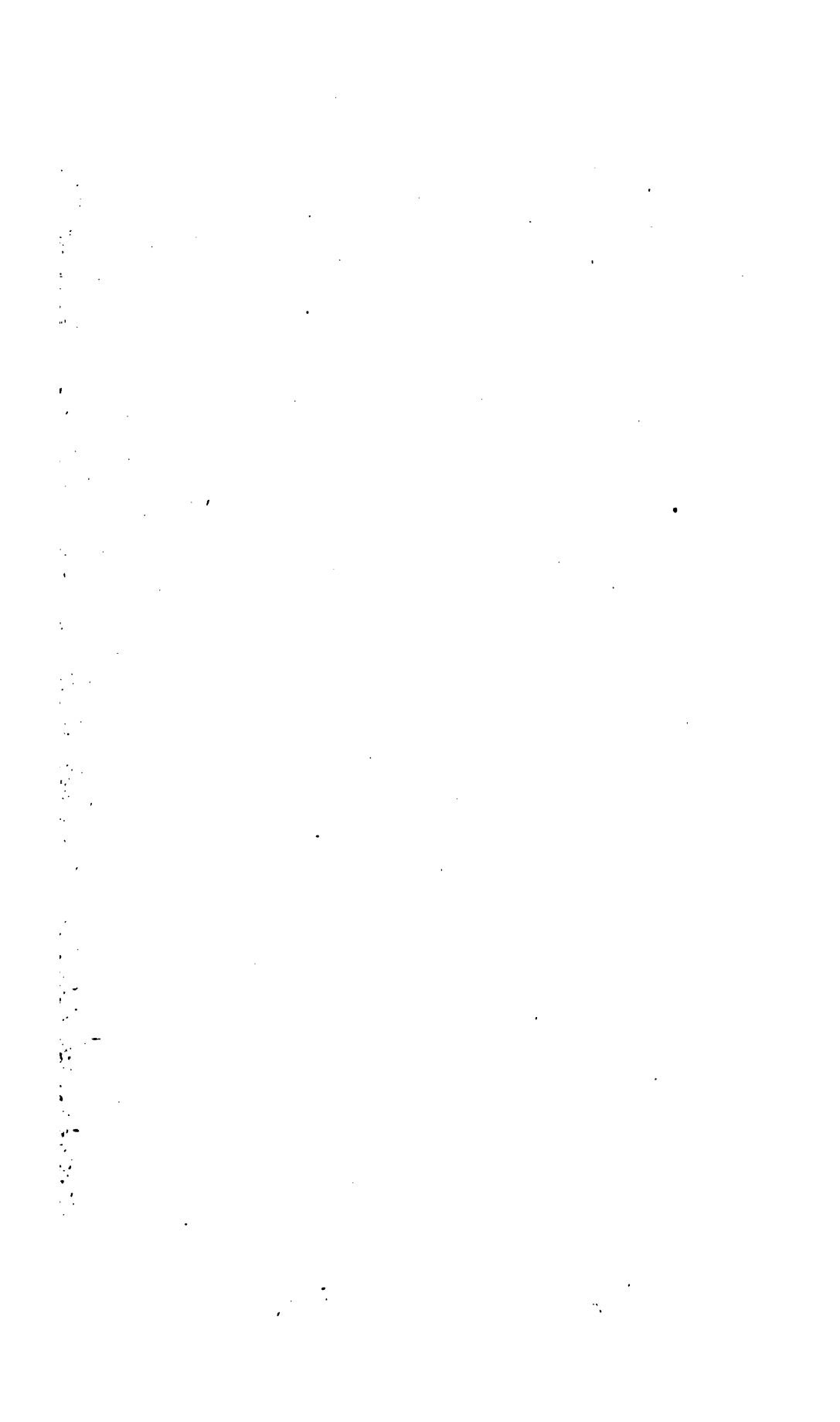
JOHN J. BANCROFT.      ANDREW J. DEVOLL.      THOS. G. GERRISH, JR.

### *Inspectors of Meters.*

HENRY E. SPRAGUE.

CHARLES H. HARVEY.

The Water office is open daily, from 9 A. M. to 12 M., and 2 to 5 P. M., and on Monday evenings, from 7 to 8 o'clock.



## REPORT OF THE WATER BOARD.

---

OFFICE OF THE LOWELL WATER BOARD,  
LOWELL, MASS., January 9, 1883.

*To the City Council of the City of Lowell:*

GENTLEMEN — The Lowell Water Board take pleasure in presenting this, the Tenth Annual Report of the Board, and in being able to congratulate our citizens and the City Council upon the continuance of the successful working of our water supply system, both as regards the unlimited supply of pure and wholesome water furnished, and the gratifying financial record of the works committed to our care.

For the kind co-operation of the City Council in granting the needed appropriations for the year, by which the calls for numerous extensions of pipe and other necessary expenditures have been met, we desire to extend our thanks, and would bespeak the same wise and hearty support in all matters which may be deemed necessary and proper for the continued prosperity of our successful system of water works, from the City Council of 1883.

The first meeting of the Board for the year 1882 was held on the evening of the 9th of January, the Board being then composed of the following members: Albert A. Haggett, President, and James W. Bennett,



from the citizens, Alderman Thomas R. Garity, Councilmen William N. Osgood and Frank Wood, elected from the City Council.

#### ORGANIZATION.

May 1st, in accordance with the requirements of the City Ordinance, the members of the Board, composed of all the before-mentioned persons (except James W. Bennett, whose term of office had just expired) and Charles C. Hutchinson, who had been elected by the City Council from the citizens, for the two years ensuing, met for their annual organization: Albert A. Haggett was re-elected President, and James M. Battles, Clerk of the Board.

During the year the calls for extensions of street-mains have been quite numerous, principally in new streets, and in the out-lying districts of the city, where, for the first time, new territory has been built upon, and much work has been performed in replacing old and small-sized pipe, which had become unequal to a proper supply of the streets where located, with larger-sized pipe, rendered necessary by the largely increased population of said streets. For a special description of the size, amount, and location of these extensions and changes, we refer to the detailed account presented in the Report of the Superintendent of the Works to the Water Board, accompanying this Report.

#### CONTRACTS.

January 28th a contract was made with R. D. Wood & Co., of Philadelphia, the lowest bidders, for 240 tons of cast-iron pipe and special castings, for use on extensions of the Works, at \$45 per ton of 2240 lbs., deliv-

ered on cars in this city. May 26th bids were received and opened for 800 tons of Powelton mine coal, to be delivered and stored within the coal house at the pumping station; and the contract for the same was awarded to the lowest bidders, Whithed & Co., of this city, at \$6.01 per ton of 2240 lbs.

#### HIGH SERVICE WORKS.

The works for the High Service Supply were fully completed June 1st, at which date William H. Ward, the contractor for the construction of the High Service Reservoir, completed his contract for said Reservoir, to the complete satisfaction of the City Engineer and the Board. We here desire to express our thanks to Mr. Ward for the faithfulness and energy which he displayed in the successful and workmanlike manner in which this important part of our High Service System was constructed by him, and for the gentlemanly and courteous manner which he exhibited in all his dealings with the Board in connection therewith.

January 9th, the City Engineer deeming it advisable that a bank wall be constructed on the westerly side of the Reservoir lot for the reception of the fence on that side of the lot, a contract was made with Mr. Ward for the construction of said wall at a cost of \$1,174.25, which contract was faithfully and satisfactorily completed.

May 12th proposals were issued for the construction of a suitable fence around the High Service Reservoir lot, and on May 19th bids for its construction were received from eight different parties, ranging from \$650, the highest, to \$520, the lowest, the latter sum being

from F. A. Parker, to whom the contract was awarded. Mr. Parker satisfactorily completed his contract, and the Reservoir lot is surrounded by a neat and substantial fence.

The amount appropriated for the construction of the High Service System was \$75,000—the *actual cost* of the same has been \$68,867.98, or \$6,132.02 less than the amount appropriated; a fact, in these days of liability to *exceed* appropriations, especially upon City work, worthy of record. We congratulate our citizens and the City Council upon the possession of a system of water supply for all sections of our municipality second to none within our knowledge, and trust that the same wise care and prudent management which have been bestowed upon it in the past, may continue so long as Lowell may require works which are such a blessing to our community.

The revenue derived from the High Service System during the past year is shown by the following table:—

BELVIDERE SECTION—containing 37 houses and 38 families, (2 new houses which are vacant and 1 house where the water is “not on” are included in the number of houses, but not included in the income)		\$530.50
CENTRALVILLE SECTION—containing 64 houses and 70 families (4 new houses which are vacant and 1 house where the water is “not on” are included in the number of houses, but not included in the income)		673.50
Hydrant Services in both sections		500.00
Total Revenue for the year		<u><u>\$1,704.00</u></u>

## INSPECTION OF FIXTURES.

Oct. 4th, the inspectors were ordered to make a careful examination and record of all water fixtures in premises of water takers, where metered water is not in use, for the purpose of ascertaining what fixtures, if any, had not been rendered to them at the annual taking in March. This inspection, which is not yet completed, has shown that large numbers of fixtures of all kinds have been added, and either through failure of the owner, or the plumber who put them, in to report the same to the inspectors at the annual visit in March, or to the Water Board office, when added, the City has failed to be the recipient of the water rates justly due from such additions. Much of the loss thus experienced we think might be obviated by the passage of an ordinance by the City Council, requiring all plumbers and pipe-fitters to be licensed by the Water Board, with such restrictions contained in said license as will secure proper returns to be made to the Water Board of the class of work proposed to be done by said plumbers or pipe-fitters in connection with the Water Works of the City. Such licenses to be granted to practical plumbers only, who have had good experience in their business. We think that much inconvenience and damage resulting from poor and inefficient workmanship could thus be avoided, and consequent waste of water be prevented. Many cities have such an ordinance, and the results therefrom are found to be valuable in preventing leaks and waste caused by bad workmanship, as well as in the certainty of having a record of all the fixtures in use in connection with the Works, before such fixtures have been placed within

the premises of the water-takers. We respectfully refer this subject to our successors upon the Water Board, and to the City Council of 1883.

#### STATISTICS.

The total amount of water pumped into the reservoir for the year was 959,931,730 U. S. gallons, against 874,996,660 U. S. gallons in the year 1881; and the daily average pumped was 2,629,950 gallons, against 2,521,604 gallons in 1881; an increase for the year of 84,935,070 gallons, and of 108,346 gallons in the daily average. The quantity of coal consumed during the year, for all purposes, excepting for High Service Supply, was 914,783 tons, against 817,288 tons in 1881. For the High Service Supply there were consumed 192,882 tons. There have been 525,166 gallons of water raised 166 feet high for each pound of coal consumed during the year. The total number of water takers is 13,000, against 12,600 in 1881, a gain for the year of 400. There are now laid 70,188 miles of street mains — the increase for the year having been 2,488 miles. The total net charges for water-rates for the year, after deducting all abatements, and the charges for service-pipes have been \$131,580, against \$122,867.22 for the year 1881 — an increase for the year of \$8,712.78.

The following table will show the charges for water, by months, from the commencement of the works to December 31, 1882, with all abatements, and total net charges:—

**CHARGES FOR WATER BY MONTHS, FROM COMMENCEMENT TO DECEMBER 31, 1882.**

MONTHS.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.
January . . . . .	. . .	\$ 363 94	\$ 418 6	\$ 150 45	\$126 51	\$ 169 13	\$ 282 44	\$ 233 73	\$ 182 58	\$ 223 37
February . . . . .	. . .	35 33	235 43	238 25	86 84	144 38	238 19	349 08	146 40	139 22
March . . . . .	\$ 6,124 94	50,200 10	65,417 68	82,249 51	80,177 52	82,225 43	80,603 65	80,567 44	89,210 88	90,856 37
April . . . . .	785 89	1,739 56	935 20	265 34	584 11	1,970 12	9,242 84	6,478 39	540 20	403 64
May . . . . .	3,088 16	3,274 09	2,147 96	874 47	1,819 65	1,121 43	2,751 35	1,476 15	879 61	1,191 41
June . . . . .	5,818 78	2,865 86	2,987 43	4,460 91	2,389 52	3,903 69	6,126 40	808 08	12,574 25	16,401 62
July . . . . .	4,833 52	1,889 03	1,926 31	582 08	3,147 78	1,261 24	1,213 13	11,457 84	873 00	959 80
August . . . . .	2,728 30	498 50	449 86	771 87	799 88	677 01	563 35	459 17	514 46	634 40
September . . . . .	2,827 07	3,245 06	865 90	405 97	3,403 90	4,908 07	6,584 86	8,108 23	10,088 19	10,904 30
October . . . . .	9,729 05	872 10	2,947 83	4,893 44	543 79	663 80	454 29	338 51	399 22	552 27
November . . . . .	761 21	634 03	573 35	1,445 65	518 72	1,220 27	1,405 89	620 56	973 16	378 97
December . . . . .	1,571 72	3,089 79	3,955 59	3,249 39	4,040 71	4,522 75	5,794 77	7,851 52	9,693 32	10,848 08
Totals . . . . .	\$39,168 64	\$69,307 39	\$82,861 00	\$99,674 93	\$98,178 93	\$102,877 32	\$115,261 20	\$118,808 70	\$125,975 27	\$133,563 45
Less abatements to date . . . . .	. . .	1,872 83	640 06	8,185 88	2,592 65	4,343 13	6,690 05	1,792 13	3,766 88	1,923 45
Net amounts . . . . .	\$39,168 64	\$67,434 56	\$82,221 54	\$91,489 05	\$95,676 28	\$98,534 19	\$108,671 15	\$117,106 57	\$122,208 39	\$131,640 00

## FINANCIAL STATEMENT.

The total gross amount of bills sent to the City Treasurer for collection for this department, for the year ending December 31, 1882, is as follows:—

For water-rates . . . . .	\$90,765 87	
metered water . . . . .	42,737 58	
Total for the use of water . . . . .		\$133,503 45
For service-pipe and laying . . . . .	\$2,293 80	
meters sold . . . . .	5,164 50	
sundry accounts . . . . .	4,683 40	
Total for pipe, meters, &c. . . . .		\$12,141 70
Total charges for the year . . . . .		\$145,645 15

The following statement exhibits the receipts and expenditures for the year, the net cost of the Water Works, including the interest on the Water Loan, and all expenses in excess of receipts for water rates; also the net cost and expenses of the Works by taxation:

Net cost of the Water Works to January 1, 1882, as  
per last Annual Report . . . . . \$2,289,801 01  
Expended during the year for water-pipes and for lay-  
ing the same, and all other items of construction:

## MATERIALS FOR MAINS, SERVICES, &amp;c. :—

Cast-iron pipe and specials . . . . .	\$9,922 31	
Wrought-iron pipe and fittings . . . . .	1,418 24	
Brass connections . . . . .	1,530 63	
Lead, lead pipe, solder and tin . . . . .	880 85	
Teaming pipe . . . . .	355 20	
Pipe and service joints, hardware, powder, fuse, &c. . . . .	211 38	
Hydrants . . . . .	1,299 39	
Hydrant covers . . . . .	100 18	
Labor on same . . . . .	10 00	
Gates for mains . . . . .	850 32	
Amounts carried forward . . . . .	\$16,578 50	2,289,801 01



<i>Amounts brought forward</i> . . . . .	\$16,578 50 2,289,801 01
Gate boxes, &c. . . . .	115 50
Service boxes . . . . .	62 49
	<hr/>
	\$16,756 49

## Labor, pay-roll on acct. of—

Extensions . . . . .	\$3,208 84
Services . . . . .	1,834 36
Piping . . . . .	644 62
Teaming . . . . .	563 75
	<hr/>
	\$6,251 57
Total ordinary construction . . . . .	\$23,008 06

## HIGH SERVICE SUPPLY :—

Cast-iron pipe . . . . .	\$900 00
Wrought-iron pipe and supplies . . . . .	10 59
Check valve . . . . .	175 00
Gates and hydrants . . . . .	166 10
W. H. Ward, balance on Reser-	
voir contract . . . . .	5,300 37
“ for bank wall . . . . .	1,174 25
Fence, Reservoir lot, grading, &c. . . . .	643 90
Rubble for Reservoir . . . . .	36 00
Worthington engine . . . . .	1,800 00
Freight on same, bolts, &c. . . . .	36 70
	<hr/>
	\$10,242 91

## Labor, pay-roll on acct. of—

Reservoir . . . . .	\$343 94
Engineering . . . . .	202 49
Extensions . . . . .	109 25
	<hr/>
	\$655 68

Total High Service construction . . . . . \$10,898 59

Total construction account . . . . . \$33,906 65

*Amount brought forward* . . . . . \$2,289,801 01

### MAINTENANCE.

#### EXPENDED FOR REPAIRS, CURRENT EXPENSES,

##### PUMPING, &c., viz. :—

##### Repairs.

Labor, pay-roll . . . . .	\$2,325 53
Wrought-iron pipe and fittings . . . . .	1,210 11
Shed at pipe yard . . . . .	111 89
Service covers and concrete . . . . .	195 87
Engineer's house, windows and blinds . . . . .	70 44
Repairing drains and gate chambers . . . . .	121 67
Packing hydrants . . . . .	74 50
Hardware . . . . .	183 96
Lime, sand, cement and brick . . . . .	115 60
Lumber . . . . .	109 90
Supplies . . . . .	107 07
Lead pipe and hose . . . . .	89 00
Fuel . . . . .	12 88

Total repairs . . . . . \$4,728 42

##### CURRENT EXPENSES. Pay-roll.

Salaries . . . . .	\$3,075 00
Inspection . . . . .	2,479 10
Foreman . . . . .	927 00
Clerk hire . . . . .	877 45
City Engineer . . . . .	272 36
	<u>\$7,630 91</u>

##### Materials.

Printing, stationery, &c. . . . .	\$544 83
Horse keeping, &c. . . . .	283 44
Repairs of wagon, harnesses, &c. . . . .	377 65
Telephone . . . . .	184 59
Flushing sewers . . . . .	116 00
Supplies . . . . .	118 41
Damages . . . . .	68 00
Filter gallery, washing, &c. . . . .	53 22
	<u>\$1,746 14</u>

Total current expenses . . . . . \$9,377 05

*Amount carried forward* . . . . . \$2,289,081 01

*Amount brought forward* . . . . . \$2,289,081 01

PUMPING ACCOUNT. Materials.

Coal . . . . .	\$4,584 12
Labor, pay-roll . . . . .	3,172 69
New boiler . . . . .	925 46
Morris engine, plungers . . . . .	219 65
Oil and tallow . . . . .	136 50
Waste and packing . . . . .	81 57
Gas . . . . .	25 94
Hardware . . . . .	15 99
Other supplies . . . . .	45 15
	<hr/>
Total pumping account . . . . .	<u>\$9,207 07</u>

RESERVOIR.

Labor, pay-roll . . . . .	\$547 50
Supplies, teaming, &c. . . . .	47 35
	<hr/>
Total reservoir account . . . . .	<u>\$594 85</u>

METER ACCOUNT.

Meters purchased . . . . .	\$4,205 04
Labor, pay-roll . . . . .	2,069 30
Repairs on meters . . . . .	90 48
Teaming . . . . .	251 64
Freight paid on meters . . . . .	44 91
Supplies . . . . .	50 51
	<hr/>
Total meter account . . . . .	<u>\$2,506 84</u>

RECAPITULATION.

Total construction account . . . . .	\$33,906 65
Repairs . . . . .	\$4,728 42
Current expenses . . . . .	9,377 05
Pumping account . . . . .	9,207 07
Reservoir account . . . . .	594 85
Meter account . . . . .	2,506 84
	<hr/>
Total maintenance account . . . . .	\$26,414 23
Meters bought . . . . .	4,205 04
	<hr/>
<i>Amounts carried forward</i> . . . . .	\$64,525 92 2,289.801 01

<i>Amounts brought forward</i> . . . .	<u>\$64,525 92</u>	2,289,801 01
Amount expended for the year, exclusive of interest . . . .	\$64,525 92	
Interest paid during the year . . .	<u>109,120 00</u>	
Total expenditure for the year . . . .		<u>\$173,645 92</u>
		<u>\$2,463,446 93</u>

## CREDITS.

Amounts received by City Treasurer during the  
year for water rates, service pipe and sun-  
dries, as follows :

For account of 1877 . . . .	\$ 3 00	
.. 1880 . . . .	1 93	
.. 1881 . . . .	12,018 32	
.. 1882 . . . .	128,307 87	
For fees . . . .	30 00	
sundries . . . .	<u>36 84</u>	
Total receipts for the year . . . .		<u>140,397 96</u>
Net cost of Works, including interest on Water Loan to January 1, 1883 . . . .		<u>\$2,323,048 97</u>
Present debt of the city, by bonds and notes, on ac- count of the construction of the Water Works . . . .		<u>\$1,875,000 00</u>
Total amount paid from City Treasury to January 1, 1883, by taxation, on account of Water Works, in excess of receipts from loans and of water rates . . . .	\$448,048 97	
Value of Water Works Sinking Funds, Jan. 1, 1883 . . . .	356,459 52	
		<u>\$804,508 49</u>
Net cost of Works, including interest on Water Loans, to January 1, 1883 . . . .		<u>\$2,323,048 97</u>
Whole amount paid by taxation, and by appropriation for the Sinking Funds, and the value of the accumu- lation of said Funds, January 1, 1883 . . . .		<u>804,508 49</u>
Debt of the city on account of Water Works, in excess of Water Works Sinking Funds, January 1, 1883 . . . .		<u>\$1,518,540 48</u>

The following table will show the gross cost of the Water Works, yearly, from the commencement of the same to Jan. 1, 1883 :

Expended in 1870	.	.	.	.	\$ 95,057 00
" 1871	.	.	.	.	624,151 66
" 1872	.	.	.	.	560,708 40
" 1873	.	.	.	.	349,717 87
" 1874	.	.	.	.	233,370 63
" 1875	.	.	.	.	275,660 78
" 1876	.	.	.	.	221,502 24
" 1877	.	.	.	.	163,814 28
" 1878	.	.	.	.	158,510 15
" 1879	.	.	.	.	150,047 82
" 1880	.	.	.	.	154,391 59
" 1881	.	.	.	.	231,171 27
" 1882	.	.	.	.	173,645 92
					<hr/>
Gross cost of Works to Jan. 1, 1883,					\$3,391,749 61
Receipts from various sources to Jan. 1, 1883					1,068,700 64
					<hr/>
Net cost of Works to Jan. 1, 1883					<u>\$2,323,048 97</u>

All portions of the works are in excellent condition, as will be seen by reference to the Annual Report of the Superintendent, accompanying this Report, and no changes or additions thereto will be required during the coming year, so far as we can foresee, other than the extensions of street-mains which may be called for in new territory not now built upon.

In closing this Report we are gratified to note the general efficiency of all, from the Superintendent of the Works to the lowest subordinate employed in this department, and we cheerfully recommend them all to our successors for their faithfulness in the discharge of the many duties which devolve upon them in the prosecution of the work allotted them to do. That the City may have the continued service of these faithful

employees in this important department of her affairs, is our earnest desire.

Appended herewith will be found the Reports of the City Engineer and Superintendent of the Works, in each of which will be found many interesting statistics, worthy of more than a passing glance. We also present the balance sheet of the City Treasurer, showing the charges and receipts for water-rates, service pipe and sundries, for the year ending Dec. 31, 1882.

Respectfully submitted.

A. A. HAGGETT,  
CHAS. C. HUTCHINSON,  
THOMAS R. GARITY,  
WILLIAM N. OSGOOD,  
FRANK WOOD,

*Lowell Water Board.*

ACCOUNTS OF THE TREASURER.



## ACCOUNTS OF THE TREASURER.

## WATER RATES, SERVICE PIPE

Dr. JOHN H. MCALVIN, *City Treasurer and Collector*

For amount of charges previously reported . . . \$104,018 47

\$104,018 47

## WATER RATES, &amp;c.,

For amount of charges previously reported . . . \$109,172 89

\$109,172 89

## WATER RATES, &amp;c.,

For amount of charges previously reported . . . \$123,879 68

\$123,879 68

## WATER RATES, &amp;c.,

For amount of charges previously reported . . . \$124,837 00

\$124,837 00

## WATER RATES, &amp;c.,

For amounts previously reported . . . \$133,648 87

January, 1882, charges . . . 808 55

February " " . . . 762 32

\$135,219 74

## AND SUNDRIES, 1877 ACCOUNT.

*of Taxes of the City of Lowell.*

CR.

By amount of collections previously reported . . .	\$101,231 41
Abatements made to December 31, 1882 . . .	2,787 06
	<u>\$104,018 47</u>

## 1878 ACCOUNT.

By amount of collections previously reported . . .	\$104,801 04
Abatements made to December 31, 1882 . . .	4,371 85
	<u>\$109,172 89</u>

## 1879 ACCOUNT.

By amount of collections previously reported . . .	\$114,114 27
Abatements made to December 31, 1882 . . .	9,765 41
	<u>\$123,879 68</u>

## 1880 ACCOUNT.

By amount of collections previously reported . . .	\$122,795 54
Collections made in 1882 . . . . .	4 93
Abatements made to December 31, 1882 . . .	1,970 24
Abatements withdrawn . . . . .	6 00
Transferred to account of 1882 . . . . .	60 29
	<u>\$124,837 00</u>

## 1881 ACCOUNT.

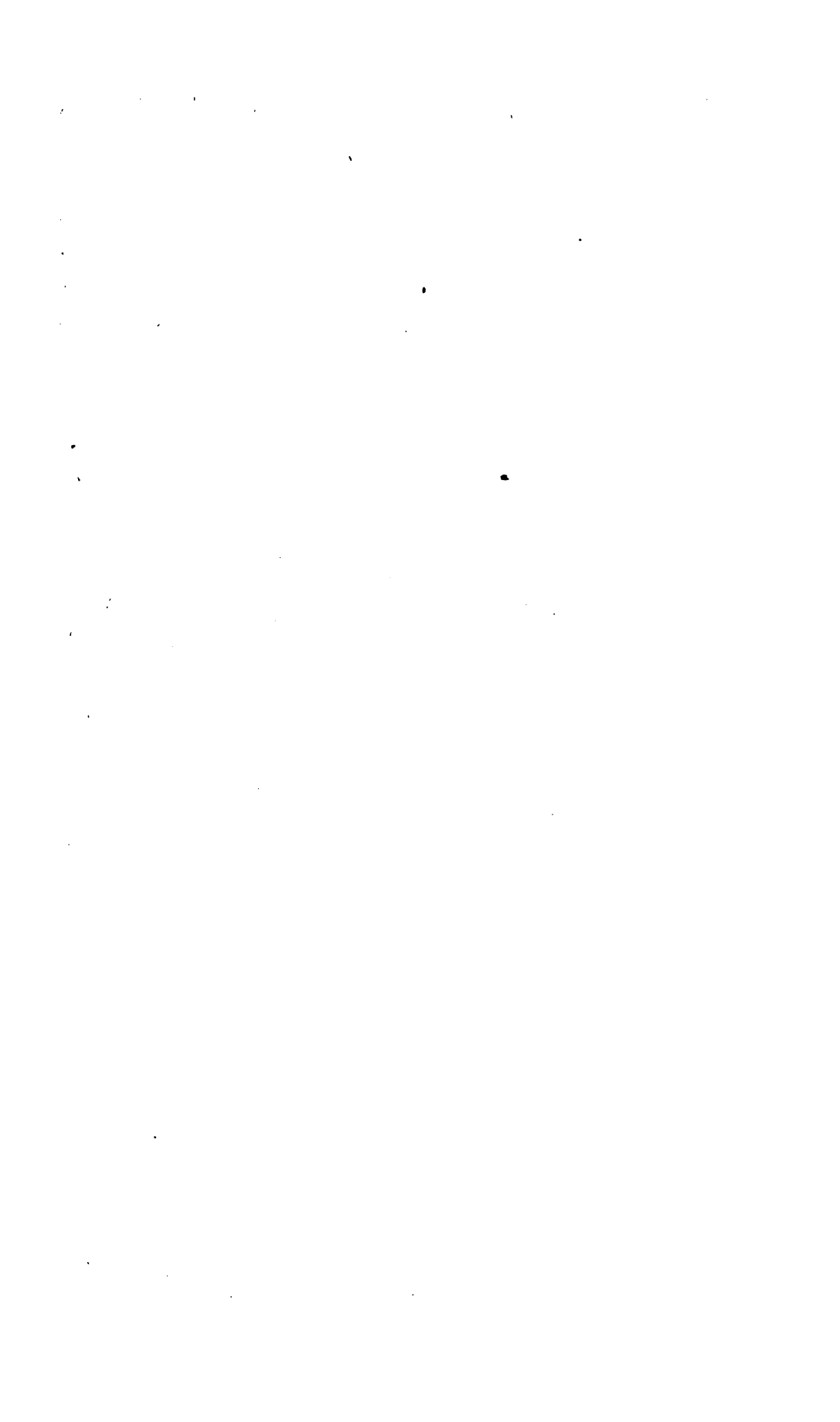
By amount of collections previously reported . . .	\$119,143 63
Collections in January, 1882 . . . . .	5,383 52
"    in February, " . . . . .	5,820 78
"    in March, " . . . . .	723 90
"    in April, " . . . . .	71 22
"    in May, " . . . . .	15 90
Transferred to 1882 account . . . . .	183 64
"    "    " . . . . .	345 74
"    "    " . . . . .	217 10
Abatements made up to December 31, 1882 . . .	3,314 31
	<u>\$135,219 74</u>



TENTH ANNUAL REPORT  
OF THE  
CITY ENGINEER TO THE WATER BOARD.

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*January 9, 1883.*



# REPORT OF THE ENGINEER.

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OFFICE OF CITY ENGINEER,  
LOWELL, MASS., Jan. 1, 1883.

## *To the Lowell Water Board:*

GENTLEMEN—The following is the Tenth Annual Report of the work done by the pumping-engines at the Lowell Water Works Pumping-Station, calculated from the records kept by Mr. James P. Roberts, the Engineer in charge. In the calculations of the “duty” of the engines nothing has been allowed for friction of water in the pumps, etc.

No “duty” has been calculated for the high-service engine. During eight days in May the high-service engine pumped directly into the distribution pipes, and performed the work very easily. It takes the water from the Beacon-street reservoir, and has a back pressure of sixty pounds. It will be seen by the following table that it has only been necessary to pump fifty-four days, or five hundred and sixty-three hours, to supply the high-service districts, which proves the engine to have sufficient capacity for many years, unless more of the low-service territory is changed to the high-service. Since January 1st, 1873, the Morris engine has pumped twenty-three hundred and eighty-four days of ten hours each, and since February 1st, 1876, the Worthington engine (low-service) has pumped two hundred and seventy days.

Table showing work done with Morris Engine (Beam and Fly-Wheel) and Boilers, for each month during the year 1882.

MONTHS.	No. of days' pump- ing.	Ave No. of hours' pump- ing per day.	No. of hours' pump- ing per month.	No. of strokes made per month.	Ave No. of strokes made per minute.	Average head, includ- ing friction, in feet.	Quantity pumped per month, in U. S. gallons.	Average quan- tity pumped in U. S. gallons.	No. gallons of water pumped to reservoir per lb. coal consumed.	Duty in lbs. 1 foot high, with 100 lbs. coal, used in pumping only, no deduc- tion for ashes or clinkers.	Duty on total coal consum- ed, no deduc- tion for ashes or clinkers.
January . . .	30	11-52	355-55	247,983	11.61	166.56	79,354,560	2,645,152	554	92,565,272	76,922,264
February . . .	28	12-03	337-35	243,212	12.00	165.28	77,827,840	2,779,566	556	91,081,938	76,519,243
March . . . .	29	11-15	326-20	224,959	11.49	165.14	71,986,880	2,482,306	540	90,272,326	74,296,130
April . . . .	20	11-27	228-55	158,284	11.52	165.16	50,650,880	2,532,544	531	90,133,264	73,118,062
May . . . .	25	11-18	282-25	195,408	11.53	165.26	62,530,560	2,505,222	538	90,388,212	74,064,227
June . . . .	27	11-31	320-00	220,547	11.49	166.85	70,575,040	2,613,890	540	90,490,134	75,114,093
July . . . .	1	9-40	9-40	6,422	11.07	171.75	2,055,040	2,055,040	321	98,030,359	45,961,104
August . . . .	24	11-41	280-40	193,235	11.47	165.81	61,835,200	2,576,466	572	88,144,857	70,015,740
September . . .	30	11-46	353-10	249,025	11.75	165.56	79,688,000	2,656,267	557	91,649,291	76,797,982
October . . . .	26	11-47	306-30	211,899	11.52	165.84	67,807,680	2,607,988	543	90,627,323	75,088,302
November . . .	26	11-39	303-00	210,003	11.55	165.17	67,200,960	2,584,652	543	91,123,050	75,215,358
December . . .	30	12-08	364-15	256,991	11.76	166.46	82,237,120	2,741,237	554	91,760,430	76,809,881
Totals and ave'gs	296	11-32	3,468-25	2,417,968	11.13	166.32	773,749,760	2,614,019	547	91,097,781	75,864,429

**Table showing work done with Worthington Duplex Engine and Boilers at Pumping Station, for each month during the year 1882.**

MONTHS.	No. of days' pump- ing.	Ave No. of hours' pump- ing per day.	No. of hours' pump- ing per month.	No. of strokes made per month.	Ave No. of strokes made per minute.	Average head, includ- ing friction, in feet.	Quantity pumped per month, in U. S. gallons.	Average quan- tity pumped per day, in U. S. gallons.	No. gallons of water raised in- to reservoir per lb. coal consumed.	Duty in lbs. 1 foot high, with 100 lbs. coal, used in pumping only, no deduction for ashes or clinkers.	Duty on total coal consum- ed, no deduc- tion for ashes or clinkers.
January . . .	5	11-19	56-35	34,631	10.21	170.06	10,735,010	2,147,122	426	70,835,033	60,426,403
February . . .											
March . . . .											
April . . . . .	5	11-36	58-00	39,243	11.28	169.70	12,165,330	2,433,066	434	68,629,775	58,125,974
May . . . . .	3	11-33	34-40	23,612	11.35	169.87	7,319,720	2,439,907	438	68,625,743	58,763,349
June . . . . .	6	11-07	66-40	41,720	10.43	167.29	12,933,200	2,155,533	449	76,017,723	62,565,588
July . . . . .	31	13-33	420-15	309,111	12.56	163.32	95,824,410	3,091,110	453	71,651,634	61,629,950
August . . . .	12	14-03	168-40	126,654	12.52	163.41	39,262,740	3,271,895	458	72,649,886	62,392,430
September . .											
October . . . .	3	11-58	35-55	25,616	11.89	163.40	7,940,960	2,646,986	434	68,011,365	59,091,838
November . . .											
December . . .											
Totals and ave'gs	65	12-56	840-45	600,587	12.05	164.15	186,181,970	2,864,338	449	71,793,493	61,468,729



*Table showing amount of coal, etc., used for Morris Engine at Pumping Station, for each month during the year 1882.*

MONTHS.	COAL CONSUMED.			
	For starting fires, in lbs.	When pumping, in lbs.	For banking fires, in lbs.	Total coal consumed.
January . .	18,000	119,000	6,200	143,200
February . .	16,800	117,700	5,600	140,100
March . . .	17,400	109,750	6,200	133,350
April . . .	12,000	77,350	6,000	95,350
May . . . .	15,000	95,280	6,000	116,280
June . . . .	16,200	108,450	6,000	130,650
July . . . .	600	3,000	2,800	6,400
August . . .	8,400	96,940	2,800	108,140
September .	17,400	119,970	5,800	143,170
October . . .	15,600	103,410	5,800	124,810
November . .	15,600	102,130	6,000	123,730
December . .	18,000	124,330	6,200	148,530
Totals . .	171,000	1,177,310	65,400	1,413,710

*Table showing amount of coal, etc., used for the Worthington Duplex Engine, at Pumping Station, for each month during the year 1882.*

MONTHS.	COAL CONSUMED.			
	For starting fires, in lbs.	When pumping, in lbs.	For banking fires, in lbs.	Total coal consumed.
January . .	2,700	21,480	1,000	25,180
February . .				
March . . .				
April . . .	3,000	23,740	1,290	28,030
May . . . .	1,800	14,300	600	16,700
June . . . .	3,900	23,720	1,200	28,820
July . . . .	24,000	182,030	5,600	211,630
August . . .	9,900	73,600	2,200	85,700
September .				
October . . .	1,800	15,900	600	18,300
November . .				
December . .				
Totals . .	47,100	354,770	12,490	414,360

Table showing work done with Worthington High-Service Engine, at Pumping Station, 1882.

MONTHS.	No. of days' pumping.	Average No. of hours' pumping per day.	No. of hours' pumping per month.	No. of strokes made per month.	Average No. of strokes made per minute.	Average head, including friction, in feet.	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. gallons.	No. of galls. of water pumped into reservoir per lb. of coal, for total coal consumed.	Coal in pounds used when pumping.
January . .	3	4-20	13-00	31,009	39.76	62.79	434,126	144,708	204	2,130
February . .	4	3-52	15-30	28,875	31.05	64.51	404,250	101,062	155	2,600
March . . .	3	3-40	11-00	19,850	30.07	64.51	277,900	92,633	154	1,800
April . . .	3	6-00	18-00	30,078	27.85	64.51	421,092	140,364	186	2,260
May . . . .	10	19-54	199-00	73,744	6.17	70.53	1,032,416	57,356	211	4,892
June . . . .	6	9-21	56-05	109,555	32.55	70.85	1,533,770	255,628	337	4,550
July . . . .	5	8-43	41-05	87,787	35.61	77.19	1,229,018	245,803	341	3,600
August . . .	7	10-21	72-25	154,577	35.57	73.73	2,164,078	270,509	316	6,850
September .	3	10-40	32-00	70,625	36.78	78.34	988,750	329,583	342	2,890
October . . .	3	10-45	32-15	62,877	32.49	77.65	880,278	293,426	423	2,080
November . .	3	10-06	30-20	64,866	35.64	76.79	908,124	302,708	324	2,800
December . .	4	10-37	42-30	87,250	34.21	78.91	1,221,500	305,375	355	3,440
Tot's and av'gs	54	10-26	563-10	821,093	24.30	71.69	11,495,302	182,465	288	39,892

## PUMPING-STATION, MORRIS ENGINE.

*Running Expenses for the Year 1882.*

Pay of engineer and firemen . . . . .	\$2,568 00
41 $\frac{333}{1000}$ tons coal (George's Creek), at \$6.384 . . . . .	28 91
423 $\frac{630}{1000}$ tons coal (Powelton), '81, at \$5.134 . . . . .	2,173 30
279 $\frac{200}{1000}$ tons coal (Powelton), at \$5.37 . . . . .	1,498 28
Wood . . . . .	5 25
Gas for lighting works . . . . .	21 73
55 gallons cylinder oil, at .75 . . . . .	41,25
49 gallons engine oil, at .45 . . . . .	22 05
1 gallon lard oil . . . . .	1 20
674 lbs. tallow, at .09 . . . . .	60 66
34 $\frac{1}{2}$ lbs. soapstone packing, at .30 . . . . .	10 28
3 $\frac{1}{2}$ lbs. Asbestos packing, at .50 . . . . .	1 69
29 $\frac{1}{2}$ lbs. hemp packing . . . . .	9 61
75 lbs. cotton waste, at .12 $\frac{1}{2}$ . . . . .	9 37
Repairs on engine and pump . . . . .	230 15
Repairs on boilers . . . . .	46 42
Sundries . . . . .	30 25
Total . . . . .	<u>\$6,758 40</u>

Cost of raising water into reservoir, per million gallons, \$8 73

Cost of raising water, per million gallons, one foot high, .05  $\frac{23}{100}$

## WORTHINGTON ENGINE.

*Running Expenses for the Year 1882.*

Pay of engineer and firemen . . . . .	\$567 00
190 $\frac{1370}{1000}$ tons coal (Powelton), '81, at \$5.134 . . . . .	978 97
7 $\frac{600}{1000}$ tons coal, at \$6.116 . . . . .	44 92
92 $\frac{300}{1000}$ tons coal (Powelton), at \$5.37 . . . . .	49 13
Wood . . . . .	3 50
Gas for lighting works . . . . .	4 80
28 gallons cylinder oil, at .75 . . . . .	21 00
10 lbs. soapstone packing, at .30 . . . . .	3 00
Amonnt carried forward . . . . .	<u>\$1,672 32</u>

<i>Amount brought forward</i> . . . . .	\$1,672 32
42 lbs. cotton waste, at .12½ . . . . .	5 25
Repairs on engine . . . . .	1 50
Repairs on boilers . . . . .	10 89
Sundries . . . . .	7 09
<b>Total</b> . . . . .	<b>\$1,697 05</b>

Cost of raising water into reservoir, per million gallons, \$9 12

Cost of raising water, per million gallons, one foot high, .05  $\frac{5}{100}$

## RESERVOIR, 1882.

The following table shows the average depth of water, the number of gallons, and the temperature of the water in the reservoir, and also the temperature of the air, for each month. The temperature of the water was taken at 6 A. M. and 6 P. M., and of the air at 6 A. M., 1 P. M., and 6 P. M.

MONTHS.	Depth in feet.	Quantity in U. S. gallons.	Temperature in degrees.	
			Of water.	Of air.
January . . . . .	18.49	28,049,700	35.4	22.5
February . . . . .	18.98	28,855,700	35.1	28.1
March . . . . .	19.73	30,129,100	35.9	33.7
April . . . . .	19.50	29,733,700	43.3	42.6
May . . . . .	19.50	29,733,700	50.8	50.7
June . . . . .	19.02	28,926,700	62.7	68.9
July . . . . .	19.48	29,698,700	70.6	75.0
August . . . . .	19.30	29,405,000	74.5	72.1
September . . . . .	19.17	29,174,700	65.9	63.9
October . . . . .	10.09	29,040,900	58.1	53.6
November . . . . .	19.97	30,531,300	47.3	35.6
December . . . . .	19.90	30,417,200	33.5	35.8

The following table shows the average monthly and daily consumption of water for the year 1882.

MONTHS.	Gallons per month.	Gallons per day.
January . . . . .	89,390,420	2,883,560
February . . . . .	78,667,110	2,809,540
March . . . . .	70,162,040	2,263,290
April . . . . .	64,919,680	2,163,990
May . . . . .	68,310,840	2,203,580
June . . . . .	82,226,510	2,774,220
July . . . . .	99,139,730	3,229,640
August . . . . .	90,840,930	3,220,680
September . . . . .	79,547,630	2,651,590
October . . . . .	75,467,480	2,434,430
November . . . . .	66,354,070	2,211,800
December . . . . .	81,528,020	2,629,940
Total and average . . . . .	957,254,460	2,622,615

#### HIGH-SERVICE SUPPLY.

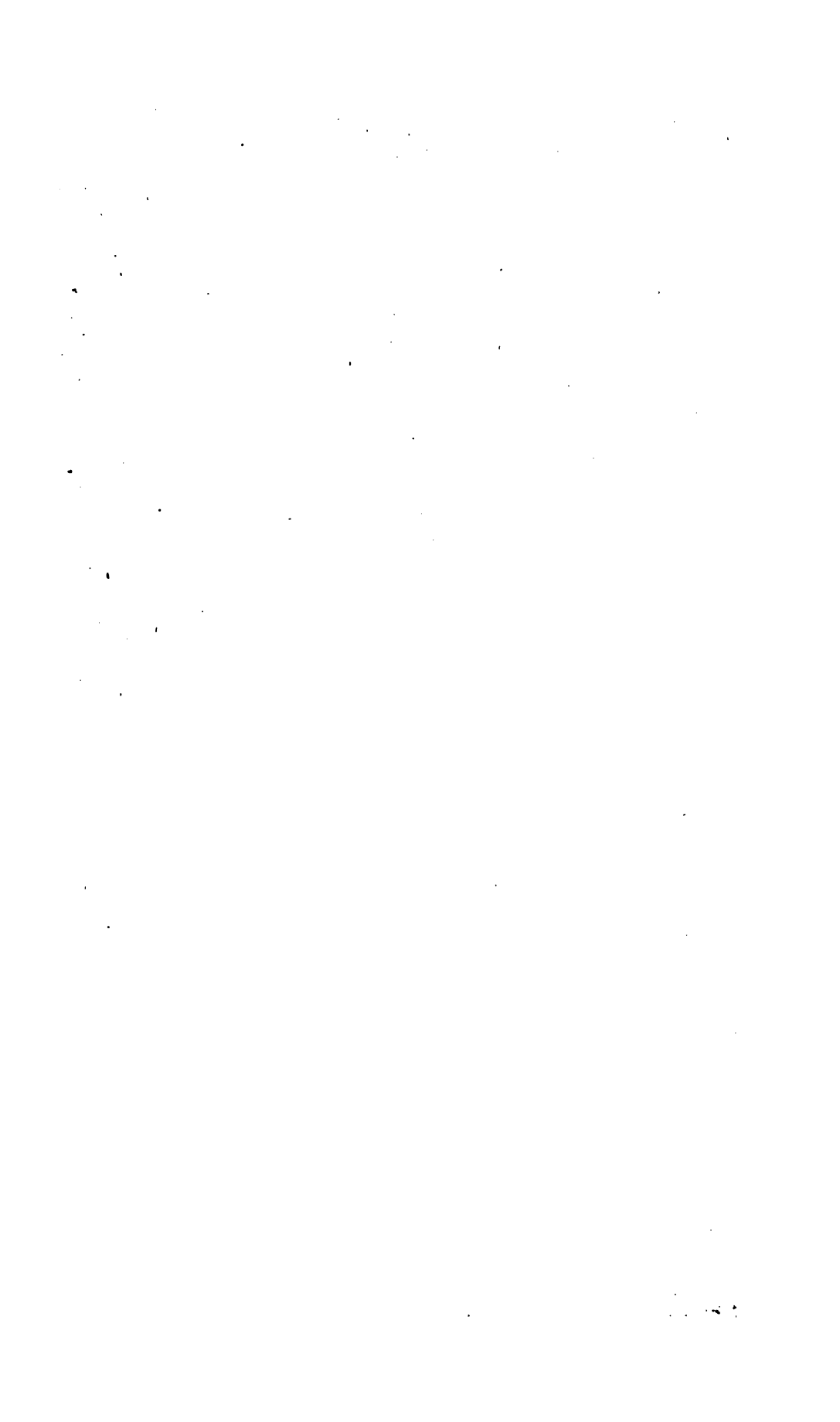
During last winter a substantial bank wall was laid on portions of the west side of the reservoir lot on Mt. Pleasant street, and the north side adjoining the city gravel lot. April 10th work was resumed on the reservoir slope, paving and concreting at top of slope. May 22d the water was drawn from the reservoir, and the puddle on the bottom was finished, and all surplus material removed. About noon on the 25th of May, water was again let in, and the reservoir was allowed to fill. The sodding and grading of the outside slope were finished May 31st, thus completing Mr. Ward's

contract, which has been done in a faithful and satisfactory manner.

The grounds were subsequently graded and a fence built around the lot, under the direction of the Superintendent of the Water Works. Although some important changes were made in the location of the distributing main, it is gratifying to state that the high-service water supply has cost \$2,830 less than the original estimate (\$71,700).

Respectfully submitted.

GEO. E. EVANS, *City Engineer.*



TENTH ANNUAL REPORT  
OF THE  
SUPERINTENDENT OF WATER WORKS,  
TO THE  
LOWELL WATER BOARD.

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*January 1, 1883.*





## REPORT OF THE SUPERINTENDENT.

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SUPERINTENDENT'S OFFICE, CITY HALL,  
LOWELL, January 1, 1883.

### *To the Lowell Water Board :*

GENTLEMEN — In compliance with the city ordinance I respectfully submit herewith the tenth annual report of the Superintendent of the Lowell Water Works for the year ending December 31, 1882.

The Works and everything connected with them are in good condition, and during the past year there has been no freezing of mains or service-pipes, and but few leaks of any account.

The total amount of water pumped is 959,931,730 gallons. The amount of water sold by meter is 229,000,000 gallons. The average amount of water used per day for each inhabitant is 40.44 gallons. This includes all the water used for street drinking fountains, manufacturing purposes, extinguishing fires, &c.

### FILTER-GALLERY AND CONDUIT.

At an examination of the filter-gallery and conduit, December 26th, the mason-work was all in good condition, and the amount of sediment in the conduit does not appear to have increased any in depth for the past four years. The spongy formation is gradually increasing on the bottom and sides of the gallery, and

although it is claimed that this never affects the quality of the water, as it is the same substance that is frequently found around the sides and bottoms of the purest springs, yet I think it would be advisable next season to build a gate-chamber at the upper end of the gallery, and have this chamber connected with the river by a pipe of suitable size, so that on opening the gate a strong current could be forced through the gallery, and by taking off the cover to the man-hole at Beaver Brook all the sediment could be washed out of the gallery and conduit.

#### PUMPING STATION.

At the pumping station the Morris engine, as usual, has done the larger part of the pumping. At the time that the pump-cylinder to the Morris engine was re-bored, July, 1881, the bucket was bushed with a brass ring shrunk on, and turned down to fit the cylinder. After running nearly a year this ring broke in two places. A new ring of very soft metal was then procured from the Atlantic Works, South Boston, and riveted to the bucket with 36 5-8-inch copper rivets. Since then it has run every day, and shows no sign yet of giving out. This constitutes all the repairs that have been needed on the engines or pumps. A corner of the engine-room has been partitioned off for an office 8 feet by 10 feet, and sheathed with black walnut and ash. Also, new windows and blinds have been put in the house occupied by the engineer. No repairs have been needed on the force-main. The fence around the reservoir grounds has been repaired and white-washed, and a portion of the land has been ploughed up and sowed with grass seed.

## HIGH SERVICE.

During the year 114,953,020 gallons of water have been pumped into the high-service reservoir. Owing to a delay in getting material the reservoir was not completed until June 1st. Previous to that time about four feet of water was all that could be kept in the reservoir, but on completion water was pumped in to a depth of 16 feet, and from 12 feet to 16 feet of water has been kept in ever since. There has yet been no settling of the banks, and to all appearances the reservoir is now perfectly tight. After the reservoir was completed the grounds around it were graded, the stones and rocks all cleared off, about twelve inches of loam spread on, and the whole sowed with grass. A bank wall averaging four feet in height has been built on a portion of the east and north sides, also the whole length of the west side on Mt. Pleasant street, and the whole grounds have been surrounded by a picket fence 7½ feet high. The high-service mains have been extended in Belvidere on Fairmount street, from the end of the pipe to the Tewksbury line; on Fairview street to D. C. Brown's house, and on Mansur street to the house of T. G. Tweed. In Centralville the high service mains have been extended on Beacon street from Tenth street to Eleventh street, and on Eleventh street to the house of Thomas Walsh. Connections have also been made on Vernon street through Sixth street to Fremont street, so that now the whole of Fremont street is on the high service. In Belvidere there are 37 houses and one fountain, and in Centralville there are 64 houses, one fountain and 3 stables now supplied with water from the high service system.

## EXTENSIONS.

During the past year 13,154 feet of cast iron mains have been laid. The mains are now extended to the last houses within the city limits on Mammoth street, Riverside street, Bridge street, Andover street, Fairmount street, Lawrence street and Chelmsford street. The 8-inch cement-lined pipe running from Cushing street to Middlesex street, through Wamesit court, across Dutton street and Western avenue, thence through what was formerly the old city stable yard, under the bed of the Pawtucket canal, has been discontinued and cut off from the Cushing street and Middlesex street mains, and the hydrants connected to this line on Dutton street and in the old city stable yard have been taken out.

## LEAKS.

There has been one leak in the high service force main on Tenth street, caused by a defective pipe, and one leak on the 20-inch line at the foot of Dutton street, at a joint.

Eight service pipes have broken off owing to the ground settling on account of the construction of sewers and house drains, and five service pipes have been found completely eaten through with rust.

## HYDRANTS.

There have been 23 post hydrants set on extensions and one flush hydrant set on the Warren street line, 5 post hydrants on Cushing street, one old style post hydrant on Adams street, and one old style flush hy-

drant on Western avenue. The Pattee & Perkins hydrant on Chelmsford street near Gates's Tannery, and the Pattee & Perkins hydrant on Grand street near Middlesex street have been taken out and replaced by post hydrants made by the Boston Machine Co. The Chapman Valve Co.'s post hydrant on Merrimack street at the head of Central street has been taken out and replaced by a flush hydrant.

#### FIRE SERVICES.

Fire services of 4-inch pipe have been put into J. M. Pevey's mill on West Adams street, the Coburn Shuttle Co.'s mill on Lincoln street, C. I. Hood & Co.'s factory, off Thorndike street, Central Block on Central street and the new post office building on Merrimack street. A 4-inch pipe has been laid for the U. S. Bunting Co.'s mill off Crosby street, which connects on to 2 hydrants and a fire service which are sealed. A 6-inch pipe has also been laid from Hall street, at Coolidge street, into the yard of the Lawrence Manufacturing Co., and besides supplying water by meter is connected to 2 hydrants, which are sealed.

A 12-inch gate has been connected on to the 20-inch main on French street, and also a gate of the same size on Amory street for sprinklers in the Boott cotton house, and the 6-inch gate on the same line on French street has been taken out and replaced by a 12-inch gate for sprinklers for the Merrimack Manufacturing Co.'s cotton house.

At Otis Allen & Son's mill on Mt. Vernon street, two 2-inch pipes have been connected on to the 2-inch



service pipe which supplies the mill with metered water. One of these has a sprinkler gate attached and the other has a hose connection and gate outside of the mill, which is to be used only in case of fire.

#### ITEMS OF OTHER WORK DONE.

The two wooden gate boxes on the 30-inch line on Vernon street and on Stackpole street, also the gate box on the 16-inch line on Willow street have been taken out and brick chambers built and covered with granite stones with a man-hole in the centre.

The stone drinking trough at Pawtucket square has been replaced by a cup and tank fountain of our own manufacture.

The drinking fountains on Branch street and Westford street have been removed, and tank fountains have been set on Westford street near Stevens street, also at the westerly junction of Branch and Middlesex streets.

The 6-inch mains on Stackpole street, on Thirteenth street, and on South Canton street have been lowered to conform to a change of grade.

The buildings and fence at the pipe yard have been repaired and painted. The fence around the high service reservoir has had two coats of whitewash. Maple trees have been set out at the pumping station and at the filter gallery grounds.

In addition to the main pipe laid, there has been laid an amount of smaller sizes as per following:

## SCHEDULE OF SMALL PIPE LAID.

STREETS.	LENGTH IN FEET.			
	$\frac{3}{4}$ inch.	1 inch.	1 $\frac{1}{2}$ inch.	2 inch.
Appleton . . . . .			120	
Bassett . . . . .			123	
Chestnut . . . . .			174	
Decatur Alley . . . . .		126		
Dutton . . . . .		67		
Gold . . . . .		18	242	
Hampshire . . . . .		56		
Harrison Ave. . . . .			130	
Howland Court . . . . .			214	
Kimball's Court . . . . .		16		
Kittredge's Court . . . . .			208	
Lombard . . . . .			247	
Linden Court . . . . .		125		
North Franklin Court . . . . .				123
Old Colony . . . . .			88	
West . . . . .			96	
West Third . . . . .	31			
Worthen . . . . .	34			
Totals . . . . .	65	408	1732	123
Total amount . . . . 2,328 feet.				

## METERS.

There are now 1079 meters in use, of which 193 were put in during the past year.

The repairs of meters have been as follows: 46 Worthington meters have been taken out and, after being tarred by the process described in the report of 1880, have been reset; 26 Worthington meters, 22 Desper meters and 15 Ball & Fitts meters have been taken out for repairs and then reset; 6 Worthingtons



and 3 Despers have been destroyed by freezing and 17 Fitts rotary meters have been worn out and replaced by other kinds. The monthly inspection of meters, which was commenced last year, has proved successful, by giving us more accurate registration, keeping the meters in better repair and guarding unnecessary waste and leaks.

The kinds and sizes of meters are shown by the following:

TABLE OF METERS IN USE DEC. 31, 1882.

KINDS.	$\frac{1}{2}$ in.	$\frac{3}{4}$ in.	1 in.	1 $\frac{1}{2}$ in.	2 in.	3 in.	4 in.		Totals.
H. R. Worthington, N. Y.	329	27	49	25	16	3	2	.	451
W. E. Desper & Co., Worcester, . . . . .	343	91	48	1	.	.	.	.	483
Ball & Fitts, Worcester . .	44	21	1	1	.	.	.	.	67
Fitts Rotary, Worcester, .	57	13	3	.	.	.	.	.	73
Crown, N. Y., . . . . .	1	1	1	.	.	.	.	.	3
Motor Register, . . . . .	.	.	.	.	.	.	.	2	2
Totals, . . . . .	774	153	102	27	16	3	2	2	1079

## SERVICES.

During the year the water has been shut off from the premises of 27 water-takers, for non-payment of water rates; and the number let on upon payment of the rates is 22.

The whole number of services remaining shut off for non-payment is 8.

There have been laid during the year 405 services, making the whole number laid to date 6283.

The amount of service pipe laid is as follows:

Laid during 1882, $\frac{3}{4}$ -inch	.	.	.	.	.	9,976 feet.
" " " 1-inch	.	.	.	.	.	2,495 "
" " " $1\frac{1}{2}$ -inch	.	.	.	.	.	1,097 "
" " " 2-inch	.	.	.	.	.	110 "
						<hr/>
Total laid during 1882	.	.	.	.	.	13,678 feet.
Add amount previously laid	.	.	.	.	.	233,345 "
						<hr/>
Total amount laid	.	.	.	.	.	247,023 "

#### WATER-TAKERS.

The whole number of water-takers (which includes each family, shop, store, office, and any other such place where city water is used) is estimated to be 13,000.

The number of abatements made during the year is 559, to wit:

ON ACCOUNT OF	1878	1879	1880	1881	1882	Total.
Water . .	\$9 00	\$18 00	\$49 43	\$658 83	\$1,923 45	\$2,658 71
Pipe, etc. .	. . .	. . .	. . .	. . .	57 16	57 16
						<hr/>
Totals . .	\$9 00	\$18 00	\$49 43	\$658 83	\$1,980 61	\$2,715 87

Respectfully submitted,

HORACE G. HOLDEN,

*Superintendent.*

## SCHEDULE No. 1.—Low Service.

## WATER PIPES LAID IN 1882.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.			
		8 Inch.	6 Inch.	4 Inch.	Total.
Agawam . . .	Extended southerly . . . . .		67		67
Andrews . . .	Extended northerly . . . . .		133		133
Beach . . . .	Extended northerly . . . . .		158½		158½
Beach . . . .	Extended northerly . . . . .		48		48
Belmont . . .	From Pine northerly . . . . .		532		532
Bridge . . . .	Extended northerly . . . . .		650½		650½
Brooks . . . .	Extended easterly . . . . .			102	102
Bowers . . . .	Fletcher and Salem . . . . .		283		283
Columbus Ave. .	Extended easterly . . . . .		135		135
Court . . . .	From Manchester southerly . . . . .		209		209
Chambers . . .	Extended westerly . . . . .		200		200
Chelmsford . .	Extended southerly . . . . .	382			382
Edson . . . .	Westford and Princeton . . . . .		375		375
East Merrimack	Extended easterly . . . . .		525		525
First . . . .	Extended easterly . . . . .		158		158
Fulton . . . .	From West southerly . . . . .		94½		94½
Grand . . . .	Extended southerly . . . . .			60	60
Hastings . . .	Pine and Liberty . . . . .		530		530
Harrison Ave. .	From Bridge westerly . . . . .			226½	226½
Kinsman . . .	From Crosby southerly . . . . .		235		235
L . . . . .	Jewett and Coburn . . . . .			197	197
Moore . . . .	From Bleachery westerly . . . . .			278½	278½
Manchester . .	Extended westerly . . . . .		297		297
Main . . . .	From Lincoln northerly . . . . .		225		225
Methuen . . .	Extended easterly . . . . .		161		161
Mason . . . .	Powell and School . . . . .		308		308
Otis . . . .	From Moore northerly . . . . .			258	258
Otis . . . .	Extended northerly . . . . .			168	168
<i>Amounts carried forward . . . . .</i>		382	5384½	1290	7056½

## SCHEDULE NO. 1.—Low SERVICE.—Concluded.

## WATER PIPES LAID IN 1882.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.			
		8 inch.	6 inch.	4 inch.	Total.
	<i>Amounts brought forward</i> . . . . .	382	5384	1290	7056½
Plain . . . .	From Chelmsford easterly . . . . .		303		303
Pine Hill . . .	From Chambers northeasterly . . . . .		343		343
Shaw . . . .	Extended easterly . . . . .		328		328
Sargent . . . .	School and Phillips . . . . .		188		188
Sagamore . . .	Shaw and Liberty . . . . .		196		196
Stevens . . . .	Extended southerly toward Parker . . . . .	441			441
Stevens . . . .	Extended northerly toward Middlesex . . . . .	141			141
So. Whipple . .	From Griffin southerly . . . . .		115½		115½
Stackpole . . .	From East Merrimack northerly . . . . .		90		90
School . . . .	Extended southerly . . . . .		212		212
Weare . . . .	From Grand westerly . . . . .		101		101
Western Ave. .	Extended easterly (old cement line across canal discontinued). . . . .		320		320
West . . . .	From River northerly . . . . .		159		159
West . . . .	Extended northerly . . . . .		12		12
Hydrants . . .	. . . . .		214½		214½
Total in feet . . . . .		964	7966½	1290	10220½

## SCHEDULE No. 2.—High Service.

## WATER PIPES LAID IN 1882.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.			
		8 inch.	6 inch.	4 inch.	Total.
Beacon . . .	Tenth and Eleventh . . . . .		429		429
Eleventh . . .	From Beacon westerly . . . . .		296		296
Fairview . . .	From Fairmount easterly . . . . .		354		354
Fremont . . .	Extended southerly . . . . .		206		206
Fairmount . . .	Extended southerly . . . . .		1057		1057
Mansur . . .	Extended easterly . . . . .		177		177
Sixth . . .	Vernon and Fremont . . . . .		298		298
Vernon . . .	Sixth and Richardson . . . . .		65		65
Hydrants . . .	. . . . .		52		52
Total in feet . . . . .					2934

## SCHEDULE No. 3.—High and Low Service.

## SUMMARY OF WATER PIPES LAID.

	8 inch.	6 inch.	4 inch.	Total.
Low Service . . . . .	964	7966½	1290	10220½
High Service . . . . .		2934		2934
Total in feet . . . . .				13154½
Pipes laid previous to 1882 . . . . .				359638
Total in feet Jan. 1, 1883 . . . . .				372692½
Total in miles Jan. 1, 1883 . . . . .				70.58

## SCHEDULE No. 4.—Low Service.

## LIST OF HYDRANTS SET IN 1882.

STREETS.	LOCATION.
Beach . . .	P East side, 352 feet north from Third Street.
Bowers . . .	P South side, 117½ feet east from Fletcher Street.
Bridge . . .	P East side, opposite Flint's house.
Belmont . . .	P East side, 440 feet north from Pine Street.
Columbus Ave.	P North side, 382½ feet east from Wilder Street.
Court . . .	P East side, 219 feet south from Manchester Street.
Chelmsford . .	P West side, 1635 feet south from Forrest Street.
Edson . . .	P West side, 356 feet north from Westford Street.
East Merrimack	P South side, 17 feet west from east line of Stackpole Street.
Fulton . . .	P West side, 46½ feet south from West Street.
Harrison Ave.	P North side, 188 feet west from Bridge street.
Pine Hill . . .	P West side, 101½ feet north from Chambers Street,
Stevens . . .	P West side, 1084½ feet south from Pine Street.
School . . .	P West side, 92 feet north from Mason Street.
Shaw . . .	P North side, 37½ feet east from west line of Sagamore Street.
Stevens . . .	P West side, 429 feet north from Princeton Street.
Warren . . .	F North side, 288 feet north from west line of Warren Street.

## SCHEDULE No. 5.—High Service.

## LIST OF HYDRANTS SET IN 1882.

STREETS.	LOCATION.
Eleventh . . .	P South side, 281 feet west from Beacon Street.
Fairview . . .	P South side, 316 feet east from Fairmount Street.
Premont . . .	P East side, 282 feet south from Sixth Street.
Fairmount . . .	P West side, 346 feet south from Hydrant opposite residence of Col. Pinder.
Fairmount . . .	P West side, 653 feet south from Hydrant opposite residence of Col. Pinder.
Fairmount . . .	P West side, opposite residence of James Ferguson.
Mansur . . .	P South side, 166 feet west from Belmont Ave.

F denotes flush hydrant.

P denotes post hydrant.

## SCHEDULE No. 6.—Low Service.

## LIST OF GATES SET IN 1882.

STREETS.	LOCATION.	8 inch.	6 inch.	4 inch.
Bridge . .	14.3 feet west from the east line of Bridge Street. 12 feet north from 3-way connecting Poor Farm Road.		1	
Belmont . .	9½ feet west from the east line of Belmont Street. 3 feet south from the north line of Pine Street.		1	
Edson . .	22 feet west from the east line of Edson Street. 6 feet north from the north line of Westford Street.		1	
E. Merrimack	16 feet south from the north line of East Merrimack Street. 4 feet west from west line of Stackpole Street.		1	
Hastings . .	10.5 feet east from the west line of Hastings Street, on north line of Liberty Street.		1	
Harrison Ave.	9.4 feet south from the north line of Harrison Ave. 6.3 feet west from west line of Bridge Street.			1
Kinsman . .	11 feet south from the north line of Kinsman Street. 2 feet west from southwest line of Crosby Street.		1	
Moore . .	17.5 feet south from the north line of Moore Street. 10 feet west from west line of Bleachery Street.			1
Main . .	11 feet east from west line of Main Street. 1.5 feet south from north line of Lincoln Street.		1	
Mason . .	8.5 feet south from north line of Mason Street. 4 feet west from west line of Powell street.		1	
Otis . .	12.5 feet east from west line of Otis Street, on north line of Moore Street.			1
Pine Hill . .	11 feet east from west line of Pine Hill Street. 2 feet north from north line of Chambers Street.		1	
Plain . .	15 feet north from south line of Plain Street 6.5 feet east from east line of Chelmsford Street.		1	
Sargent . .	13 feet north from south line of Sargent Street. 3 feet west from west line of School Street.		1	
West . .	28.5 feet west from east line of West Street. 1.7 feet south from north line of River Street.		1	
Weare . .	18 feet north from south line of Weare Street. 6 feet east from west line of Grand Street.		1	

## SCHEDULE No. 7.—High Service.

## LIST OF GATES SET IN 1882.

STREETS.	LOCATION.	8 inch.	6 inch.	4 inch.
Beacon . .	13½ feet east from the west line of Beacon Street, on the north line of Tenth Street.		1	
Fairview . .	16 feet north from the south line of Fairview Street. 2 feet east from the east line of Fairmount Street.		1	

## SCHEDULE No. 8.

## PROPERTY AT PIPE YARD JAN. 1, 1883.

## PIPE AND SPECIALS.

DIAMETER IN INCHES.	4	6	8	10	12	16	20	24	30
Lengths, . . . . .	13	69	30	97	5	19	7	15	
Cut pieces, whole length in feet	2	3	1	1	1	30			
Second-hand, in feet . . . . .									
Curves . . . . .	11	29	22	2	16	4	11	3	4
Sleeves . . . . .	7	4	12	4	20	10	1	8	5
Half Sleeves . . . . .								7	1
Caps . . . . .	9	5	37		18	3	1	1	

Diam. in inches.	4x4	6x4	6x6	8x6	8x8	10x6	12x6	12x8	12x12	16x12	16x6	16x8	16x16	20x12	20x16
3-Ways	..	6	22	14	4	2	21	8	..	..	2	1	..	3	..
4-Ways	1	..	13	7	7	..	9	2	2	3	1	..	1	..	..
Reducers	..	8	..	14	..	..	8	5	..	1	..	..	..	..	..

**4-Ways.**—1 2x1½-inch. 1 2x1-inch. 2 2x½-inch. 1 1½x1-inch. 16 1x1-inch, 11 1x½-inch. 35 ½-inch. **3-Ways.**—3 2x2-inch. 7 2x1½-inch. 5 1½x½-inch, 2 1½x1-inch. 8 1½x½-inch. 3 1½x1-inch. 7 1-inch. 9 1-inch. **Elbows.**—5 2-inch. 9 1½-inch. 175 ½-inch. 5 ½-inch. 11 1½-inch. 23 1x½ inch. 1 2x1-inch. 16 1½-inch. **Turns.**—7 1-inch. 9 ½-inch. **Wrought Iron Pipe.**—10 feet 2½-inch. 20 feet 2-inch. 75 feet 1½-inch. 100 feet 1-inch. 100 feet ½-inch. 30 feet ¼-inch. **Lead Connections.**—2 2-inch. 10 1-inch. 15 ½-inch. 10 1-inch for cement pipe. 14 ½-inch for cement pipe. 11 ½-inch for



cement pipe. **Corporation Cocks.**—30 1-inch, 6  $\frac{3}{4}$ -inch, 17  $\frac{1}{2}$ -inch, 9 1-inch for cement pipe, 13  $\frac{3}{4}$ -inch for cement pipe, 11  $\frac{1}{2}$ -inch for cement pipe. **Stop and Waste Cocks.**—1  $\frac{1}{2}$ -inch, 31 1-inch, 6  $\frac{3}{4}$ -inch, 17  $\frac{1}{2}$ -inch old style. **Brass Unions.**—41 1-inch, 7  $\frac{1}{2}$ -inch. **Iron Unions.**—3 1-inch, 150  $\frac{1}{2}$ -inch, 2  $\frac{1}{2}$ -inch, 5 2-inch. **Sockets.**—6  $\frac{1}{2}$ -inch, 26 1-inch, 17  $\frac{1}{2}$ -inch. **Plugs.**—1  $\frac{1}{2}$ -inch, 16 1-inch, 18  $\frac{3}{4}$ -inch, 10  $\frac{1}{2}$ -inch. **Couplings.**—1  $\frac{1}{2}$ -inch, 45 2-inch, 29  $\frac{1}{2}$ -inch, 2  $\frac{1}{4}$ -inch, 39 1-inch, 118  $\frac{3}{4}$ -inch. **Bushings.**—1 2x $\frac{1}{2}$ -inch, 17 1x $\frac{1}{2}$ -inch. **Sundries.**—2 derricks, 1 pipe testing machine, 3 tool boxes, 48 sidewalk boxes, 6 iron sidewalk boxes, 2 cords wood, 1 combination fountain, 4 lead-pots, 2 furnaces, 2 tons hay, 11 work benches, 1 large map of main pipe, 1 10-foot ladder, 1 coal stove, 1 coal hod, 2 framing chisels, 2 zinc pumps, 1 counter scale, 4 tool chests, 4 chairs, 1 12-foot ladder, 1 apparatus for testing meters, 1 copper force pump, 3 tapping machines, 4 brooms, 7 galvanizers, 6 iron buckets, 1 keg 10d. nails, 1 keg 20d. nails, 2 wagon wrenches, 36 assorted wrenches, 12 monkey wrenches, 8 rammers, 3 paving mauls, 33 shovels, 75 picks, 3 hoes, 8 draught chains, 1 bbl. cement, 1 bbl. white clay, 2 snow shovels, 25 pick-handles, 9 crowbars, 60 feet rubber hose, 1 hose reel, 1 copper goose-neck, 2 brass reducers, 2 portable closets, 13 lanterns, 1 gross lamp wicks, 4 hand saws, 2 buck saws, 1 saw horse, 1 leather tool-bag, 1 tin match-safe, 30 calking sets, 3 nail hammers, 8 striking hammers, 2 paving hammers, 2 stone hammers, 3 sledge hammers, 4 rubber connections, 1 fore-plane, 65 feet tile drain pipe, 250 sidewalk caps, 3 pairs rubber boots, 1 pair rubber wading pants, 200 feet canvas hose, 20 iron lug-straps, 250 lbs. iron bolts, 1 keg spikes, 26 iron valves, 9 rubber packings, 3 solder-furnaces, 2 iron rakes, 2 iron-wood mallets, 3 soldering irons, 8 assorted files, 12 gravel screens, 5 hanging irons for bridges, 2 3-foot screws, 1 bale sand bags, 1 machine for cement-lining pipe, 10 iron bands for pipe, 5 lbs. cotton waste, 6 hydrant dippers and chains, 1 press drill, 4 washer cutters, 1 grindstone, 300 lbs. iron, 1 set blacksmith tools, 9 screw drivers, 10 lbs. iron washers, 30 lbs. assorted nuts, 6 calking hammers, 100 lbs. brass hinges, 1 set steel numbers, 1 lathe dog, 1 foot-lathe, 1 universal chuck, 2 hatchets, 2 axes, 2 brass faucets, 30 brass seals, 2 ratchet dies, 814 lbs. steel in drills, 6 scrapers for blasting, 8 pipe wedges, 2 yarning irons, 1 sieve, 1 ratchet cutter, 4 pipe vises, 2 iron buckets for testing meters, 12 cold-chisels, 1 bit-stock, 3 bits, 3 large lead ladles, 5 sling-ropes, 4 dies, 3 die plates, 13 pipe-tongs, 2 pipe cutters, 2 trowels, 8 gate-screws, 7 hydrant screws, 2 iron rakes, 2 square-point shovels, 8 wood plugs for main pipe, 5 lbs. shims and wedges, 1 root axe, 1 dualin pot, 1000 lbs. iron rods, 1 10-gallon can, 1 5-gallon can, 1 2-gallon can, 1 1-gallon can, 3  $\frac{1}{2}$ -gallon cans, 4 1-quart measures, 1 4-quart wood measure, 1 tunnel, 2 desks, 1 40-foot leather belt, 1 blacksmith shop, 1 work shop, 1 carriage house, 1 stable, 1 shed for storage, 1 grain box, 1 horse, 3 harnesses, 1 canvas horse-cover, 2 horse blankets, 2 surcingles, 1 halter, 1 horse brush, 2 dusters, 1 carriage cover, 3 forks, 2 wagon jacks, 1 pung, 2 express wagons, 25 1-inch brass union nipples, 6  $\frac{1}{2}$ -inch union nipples, 51 cut glands for meters, 10 ends to Worthington meter, 1 surface plate, 2 sheets emery cloth, 3 sets packing patterns, 13 Worthington meter indicators, 5 lbs. leather, 17 piston rods for meters, 1 wire brush, 2 oil pans, 1 oil brush, 1 indicator for Desper meter, 1 brass lantern, 1 brass lamp, 2 siphons with pipe attached, 125 feet block tin tubing attached to force pump, 1 solder pot and mould, 1 pair pliers, 1 pair cut nippers, 2 valves and valve seats for Worthington meter, 5 hard packings for meters, 1 keg blasting powder, 6 hammer handles, 1 16-foot straight-edge, 9 steel points, 2000 lbs. lead, 3 sets blocks, 1 fall rope, 6 tag ropes, 2 framing squares, 1 iron tamping bar, 1 stop gate wheel, 15 1-inch caps, 17  $\frac{3}{4}$ -inch caps, 8  $\frac{1}{2}$ -inch caps, 2 gate frames, 2 gate covers, 3 gate covers, old style, 7 hydrant frames, 11 hydrant covers, 2 hydrant covers, old style, 2 hydrant frames, old style, 2 2-inch rotary meters, second-hand, 1  $\frac{1}{2}$ -inch rotary, second-hand, 3 1-inch rotary, second-hand, 1  $\frac{3}{4}$ -inch rotary, second-hand, 6  $\frac{1}{2}$ -inch rotary, second-hand, 1  $\frac{1}{2}$ -inch Ball & Fitts, second-hand, 13  $\frac{1}{2}$ -inch Desper meters, 2 2-inch Worthington meters, 1 iron tube pump and boring machine. The above named property is valued at \$17,000.00.

***Tools at Filter Inlet.***

2 iron-tooth rakes, 11 shovels, 1 rammer, 1 axe, 2 ice-chisels, 1 gate wrench, 1 nail hammer, 1 pick, 2 brooms, 1 wheelbarrow. The above named property is valued at \$20.00.

***Tools at Reservoir.***

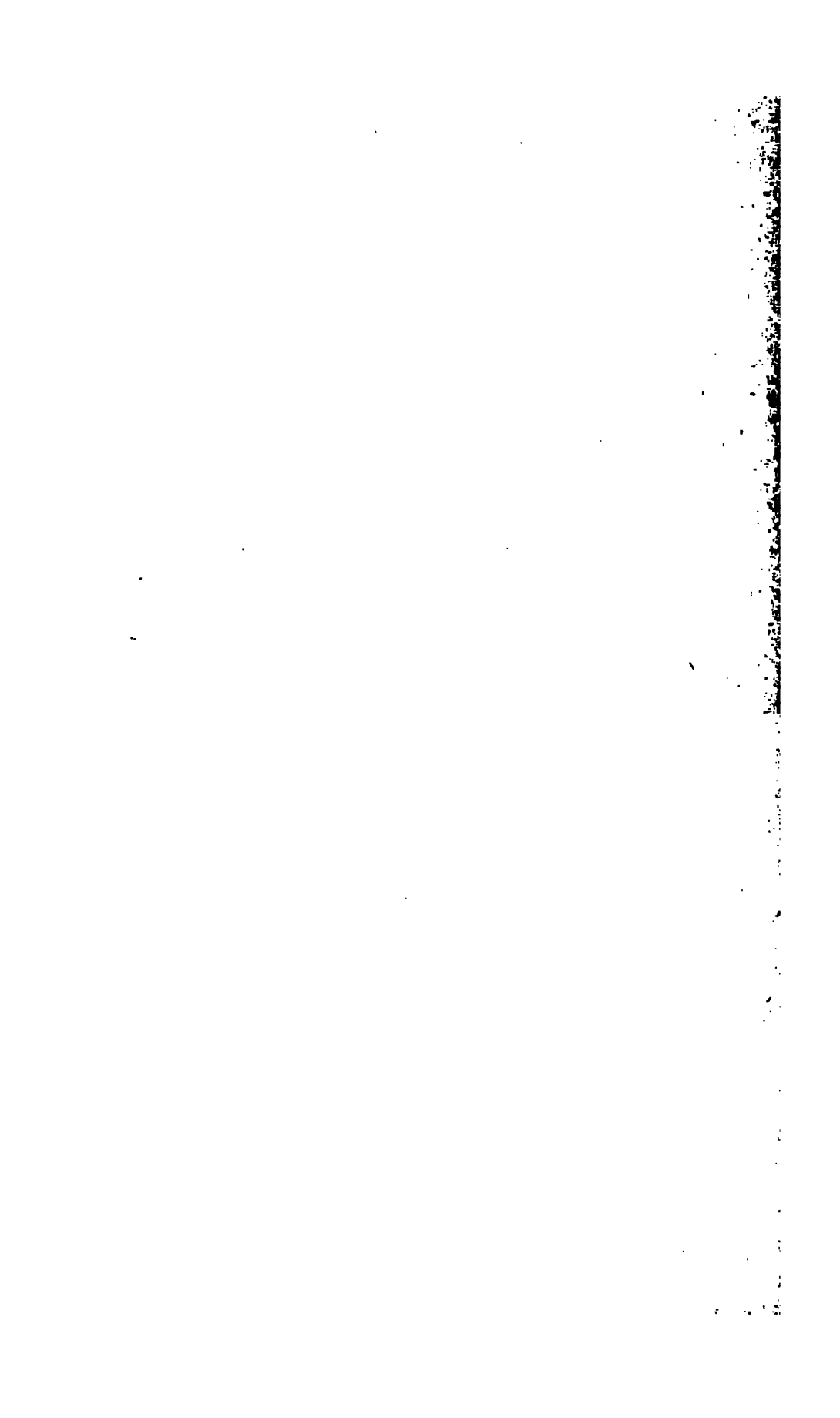
1 grindstone, 2 iron rakes, 3 forks, 6 shovels, 1 sod cutter, 1 axe, 1 saw, 2 hoes, 2 scythes, 2 snathis, 1 grass hook, 1 wheelbarrow, 1 coil rope, 2 spare screws, 2 thermometers, 1 lantern, 1 water-gauge, 1 apparatus for sealing gates, 2 screw drivers, 2 monkey wrenches, 2 files, 1 safe, 1 key-rack, 2 picks, 1 steel prodding bar, 1 shovel, 1 atlas of Lowell, 1 atlas of Middlesex County, 1 black-walnut book-case. The above named property is valued at \$25.00.

***Property in Water Board and Superintendent's Office.***

17 chairs, 2 high stools, 1 letter press, 3 desks with drawers, 3 standing desks, 1 roll-cover desk, 3 office tables, 1 book-case, 1 clock, 3 thermometers, 5 ink stands, 1 tumbler, 4 maps of Lowell, 1 map of water-distributing pipes, 3 waste baskets, 3 mats, 3 hat-racks, 6 spittoons, 8 assorted wrenches, 1 tin match-safe, 1 lantern, 1 water-gauge, 1 apparatus for sealing gates, 2 screw drivers, 2 monkey wrenches, 2 files, 1 safe, 1 key-rack, 2 picks, 1 steel prodding bar, 1 shovel, 1 atlas of Lowell, 1 atlas of Middlesex County, 1 black-walnut book-case. The above named property is valued at \$500.00.

***Property and Tools at Engine House.***

1 vise, 1 work bench, 1 portable forge, 8 sets brasses for engine, 2 sets differential blocks, 1 piece 2-inch rope, 2 sets fire irons, 1 brass hydrant, 3 axes, 11 wrenches, 1 hand-saw, 2 jack-screws, 26 cold-chisels, 1 ratchet drill, 1 socket-drill, 3 calking chisels, 1 barometer, 2 thermometers, 1 water cooler, 1 desk, 1 indicator, 1 oil cupboard, 2 oil dishes, 1 platform scale, 4 crowbars, 64 feet  $\frac{1}{2}$ -inch chain, 16 eyebolts, 1 truck, 1 key wrench, 1 wrench for air pump, 1 iron wheelbarrow, 2 hand saws, 1 buck-saw, 1 saw-horse, 2 gas lamps, 1 high grade thermometer, 4 brass bolts  $\frac{1}{4}$ -inch diameter for pump valve, 5 spare pump valves, 5 sets spare weights for valves, 11 socket wrenches, 7 pairs gas tongs, 11 finished wrenches Morris engine, 11 finished wrenches Worthington engine, 3 sledge hammers, 12 drills, 1 black-walnut cabinet, 9 chairs, 2 lengths hose, 6 copper lamps, 4 shovels, 1 floor brush, 100 bolts assorted sizes, 2 bit-stocks, 3 bits, 1 25-foot ladder, 1 20-foot, 1 8-foot, 1 pair steps, 1 hoe, 2 racks, 1 small die plate, 1 fore-plane, 3 monkey wrenches, 100 feet 2-inch rope, 4 chisel bars, 6 small taps, 4 finished socket wrenches Worthington engine, 2 14-quart iron pails, 4 hand hammers, 1 extra set grates for boiler, 1 grindstone, 1 anvil, 2 shovels, 1 clock. The above named property is valued at \$105,300.00.



1424

ELEVENTH  
ANNUAL REPORT

OF THE

★  
LOWELL WATER BOARD  
TO THE CITY COUNCIL.

ACCOMPANIED BY THE REPORTS OF THE CITY ENGINEER AND OF THE  
SUPERINTENDENT OF WATER WORKS TO THE BOARD OF HEALTH.

JANUARY 15, 1884.



LOWELL, MASS.:  
COURIER PRESS: MARDEN & ROWELL.  
1884.



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JANUARY 15, 1884.



LOWELL, MASS.:  
COURIER PRESS: MARDEN & ROWELL.  
1884.

42853

RECEIVED  
1908

## CITY OF LOWELL.

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IN WATER BOARD, January 15, 1884.

Read and accepted, and ordered to be transmitted to the City Council.

Attest.

HORACE H. KNAPP, CLERK.

---

IN COMMON COUNCIL, January 15, 1884.

Read, and sent to the Board of Aldermen.

DAVID CHASE, CLERK.

---

IN BOARD OF ALDERMEN, January 15, 1884.

Received and read.

DAVID W. O'BRIEN, CITY CLERK.

## WATER BOARD, 1884.

---

*President* . . . . . ALBERT A. HAGGETT.

Term expires first Monday in May, 1885.

CHARLES C. HUTCHINSON.

Term expires first Monday in May, 1884.

Alderman GEORGE W. FIFIELD.

Councilman EDWARD B. PEIRCE. Councilman JOHN J. HOGAN.

*Clerk* . . . . . HORACE H. KNAPP.

*Superintendent of Works* . . . . . HORACE G. HOLDEN.

*Foreman of Works* . . . . . THOMAS DOYLE.

*Engineer at Pumping Station* . . . . . JAMES P. ROBERTS.

*Service Clerk* . . . . . LEONARD T. FARRIS.


*Meter Clerk* . . . . . WILLARD S. KNOWLTON.

### *Inspectors.*

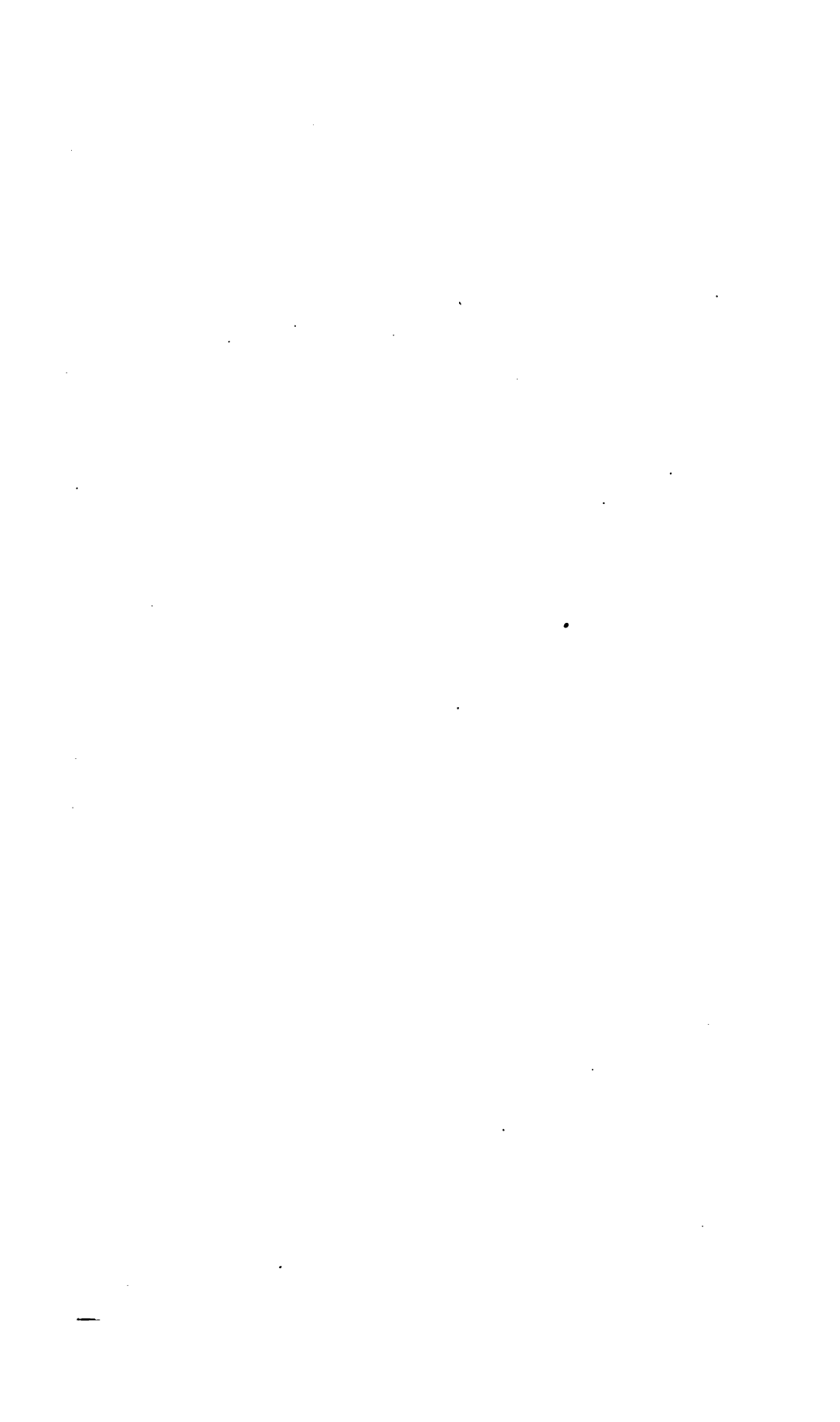
JOHN J. BANCROFT. ANDREW J. DEVOLL. THOS. G. GERRISH, JR.

### *Inspectors of Meters.*

HENRY E. SPRAGUE. CHARLES H. HARVEY, TIMOTHY H. BRENNAN.

 The Water office is open daily, from 9 A. M. to 12 M.; and from 2 to 5 P. M., and on Monday evenings, from 7 to 8 o'clock.





# REPORT OF THE WATER BOARD.

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OFFICE OF LOWELL WATER BOARD,  
LOWELL, MASS., Jan. 15, 1884.

*To the City Council of the City of Lowell :*

GENTLEMEN — The Lowell Water Board, in herewith presenting this, the Eleventh Annual Report of the Board regarding the condition of the Works under its care and management, is much gratified in congratulating the City Council and the citizens of our municipality upon the continued prosperity of this important branch of our public works, as shown by the abundant supply of pure water furnished, excellent condition of all portions of the Works, and the still continued increase in the water rates received therefrom — the latter being \$12,185.03 in excess of the receipts for the year 1882.

For this excellent condition of the affairs committed to our charge we desire to thank the City Council of 1883 for its kind co-operation in furnishing the Board with the necessary appropriation for the year just closed, by which we have been enabled to meet the many calls for extensions of pipe, and all the necessary expenditures for the proper care and support of the Works, by which the resultant increase in water-rates is made possible,— this, with the faithful and efficient work of those in the active charge of the Works, from the superintendent to the lowest subordinate employed

thereon, has contributed to the successful results of the year past.

That the same kind and considerate co-operation of the City Council of 1884 may be granted to our successors, and that the faithful services of the present working force of the department—many of whom have served from the beginning thereof—may be retained in the future, and thus the continued success of the Works be assured, is our earnest hope.

The first meeting of the Board for the year 1883 was held on the evening of Jan. 9th, the Board being composed of the following members: Albert A. Haggett, President, and Chas. C. Hutchinson from the citizens, Alderman George W. Fifield, Councilman Edward B. Peirce and John J. Hogan from the City Council.

#### ORGANIZATION.

The annual organization of the Board, in accordance with the requirements of the City Ordinance, occurred on May 7th, the membership thereof being the same, Albert A. Haggett having been re-elected by the City Council, from the citizens, for the two years ensuing. Albert A. Haggett was elected President, and Horace H. Knapp Clerk of the Board—the latter, succeeding Mr. James M. Battles, who for several years faithfully filled the position—has proved a painstaking and efficient Clerk, and faithfully devoted himself to the somewhat arduous and trying duties of the position; and we hereby desire to record our commendation of his efficiency concerning the important and manifold duties pertaining to the office.

## LICENSING PLUMBERS AND PIPE-FITTERS.

On March 2nd, the Board, after due consideration, and consultation with regular plumbers and pipe-fitters of the city, petitioned the City Council for the enactment of an ordinance authorizing the Lowell Water Board to license plumbers and pipe-fitters—said licensed plumbers and pipe-fitters, only, to be allowed to prosecute their calling in connection with the pipes connected with the Water Works. The suggestions considering the need of such an ordinance were fully set forth by our immediate predecessors in the Tenth Annual Report of the Water Board, and met our hearty commendation. On May 22nd, the Joint Committee on Ordinances and Legislation of the City Council reported that they found no authority by which the power to license can be granted to any branch of the “City Government,” saying, “the power, as we believe, by the Charter and Public Statutes, is vested in the Board of Aldermen, and cannot be delegated or transferred except by statute law, and, as far as we know, no such statute exists; we would therefore most respectfully report, inexpedient to legislate.” This report was accepted by the City Council.

We still believe in the propriety of such action as was recommended by the Water Board of 1882 concerning this important subject, and if not deemed advisable to petition the Legislature for the passage of an act authorizing the Water Board to issue such licenses, would respectfully urge that the Board of Aldermen exercise such authority, and grant such licenses through the recommendation of the Water Board. By

such action the evils now resulting from poor and inefficient workmanship would be avoided, and the certainty of having a record of all fixtures proposed to be used in connection with the Works, before said fixtures had been placed within the premises of water-takers, would be assured.

#### CONTRACTS.

Feb. 2nd, a contract was made with the Gloucester Iron Works of Philadelphia, the lowest bidder, for 371 tons of cast-iron pipe and special castings, for use on extensions of the Works, at \$37.87 per ton of 2240 lbs., delivered on the cars in this city. May 9th, proposals were received and opened from Lowell dealers, for 1000 tons of Powelton mine coal, to be delivered and stored within the coal house at the pumping station, and the contract for supplying the same was awarded to the lowest bidder, D. W. Horne & Son, at \$5.59 per ton of 2240 lbs.

#### PURITY OF OUR WATER.

The subject of the purity of our city water is one in which all our citizens are deeply interested, and none more so than are the members of the Water Board. For several years past, periodically, especially when some new spring water is discovered which is considered a panacea for all the ills, from in-growing nails to baldness, which humanity is heir to, the public has been informed of the bad condition of the city water by some superstitious un-named correspondent of the daily press. The fact that the superintendent, several times during each year, has all the water in the street mains and in the conduit lines "blown out," by which

every particle of sediment therein contained is forced therefrom, as well as the often cleaning out of the pump-well at the pumping station, is sufficient evidence that the necessary care is taken in this direction; while the further fact that the Water Board, in the discharge of the high trust committed to their care, often resort to chemical analysis in order to ascertain the character of our water for purity — the last analysis of which was had Sept. 19th, 1883 — is further evidence of a proper regard for the protection of our citizens from a tainted supply of water.

The analysis above mentioned was made by S. P. Sharples, the State Assayer of Massachusetts, and was of three samples of water, viz.: One of city water, drawn at the Government Building, one of Pentucket spring water, located on the bank of the Merrimack River, below Hunt's Falls, in Belvidere, and one of water from a well on the Lawrence Corporation, long in use, and considered good water. The results of the analysis are shown in the following report of the State Assayer. These samples contained in 100,000 parts the following : —

	Quality.	Inorganic Matter.	Volatile & Organic Matter.	Total Residue at 212° F.	Ammonia Free.	Ammonia Albuminoid.	Nitrates.	Chlorine in Chlorides.	Sulphate of Lime.
City Water,	Excellent.	2.00	3.00	5.00	Traces.	.0100	None.	Present.	Present.
Pentucket Sp'g do.,	"	4.00	3.50	7.50	"	.0040	"	"	"
Well do.,	Good.	6.00	5.00	11.00	"	.0060	"	Strong.	Strong.

We would also call attention to an analysis of our city water made by W. P. Atwood, Esq., chemist for the Hamilton Manufacturing Company of this city, at the request of the proprietors of the Daily Citizen,



Feb. 20th, 1883, a report of which was published by that paper at the time, in which substantially the same results were found. With the above record we think all unprejudiced and fair-minded persons will be satisfied with the continued use of a water which by so good authority is pronounced "excellent."

#### STATISTICS.

The total amount of water pumped into the reservoir for the year was 1,042,490,500 U. S. gallons, against 959,931,730 U. S. gallons in 1882; and the daily average pumped was 3,021,655 gallons, against 2,629,950 gallons in 1882; an increase for the year of 82,558,770 gallons, and of 391,705 gallons in the daily average. The quantity of coal consumed during the year for all purposes, excepting for the High Service supply, was 983 $\frac{520}{100}$  tons, against 914 $\frac{70}{100}$  tons in 1882. For the High Service supply the consumption during the year was 27 $\frac{480}{100}$  tons, against 19 $\frac{882}{100}$  tons in 1882. There have been 524 $\frac{70}{100}$  gallons of water raised 167 $\frac{1}{10}$  feet high for each pound of coal consumed during the year.

The total number of water takers is 13,800, against 13,000 in 1882, a gain for the year of 800. There are now laid 73 $\frac{80}{100}$  miles of street mains — the increase for the year having been 3 $\frac{20}{100}$  miles. The total net charges for water rates for the year, after deducting all abatements, and the charges for service pipes, have been \$141,316.82, against \$131,580 for the year 1882 — an increase for the year of \$9,736.82.

The following table will show the charges for water, by months, from the commencement of the Works to December 31, 1883, with all abatements, and total net charges: —

**Charges for Water by Month, from Commencement to December 31, 1883.**

MONTHS.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
January.....	• • •	\$ 363 94	\$ 418 96	\$ 150 46	\$ 126 31	\$ 160 13	\$ 282 44	\$ 223 73	\$ 192 38	\$ 233 37	\$ 271 52
February.....	• • •	35 53	235 43	238 35	86 84	144 38	228 19	349 08	146 40	130 22	136 06
March.....	\$ 6,124 94	50,200 10	65,417 68	82,249 51	89,177 52	82,225 43	80,603 69	80,507 44	89,210 88	90,856 37	94,686 65
April.....	785 89	1,739 56	935 20	206 34	584 11	1,970 12	9,242 84	6,478 39	540 20	465 64	263 10
May.....	3,908 16	3,274 69	2,147 96	874 47	1,819 65	1,121 43	2,731 35	1,476 15	879 61	1,191 41	984 84
June.....	5,818 78	2,865 86	2,087 43	4,400 91	2,789 52	3,903 69	6,126 86	808 08	12,574 25	16,401 62	17,757 44
July.....	4,833 52	1,889 03	1,926 31	582 68	3,147 78	1,261 24	1,213 13	11,437 81	873 00	969 80	1,059 32
August.....	2,728 30	498 50	449 86	721 87	756 88	677 01	563 35	459 17	514 46	624 40	902 76
September.....	2,827 07	3,245 06	865 90	496 97	2,453 90	4,998 07	6,524 86	8,108 23	10,088 19	10,004 30	12,467 32
October.....	9,729 05	872 10	2,947 59	4,893 44	543 79	683 80	464 29	328 51	300 22	352 27	941 81
November.....	761 21	634 03	323 36	1,445 66	618 72	1,220 27	1,405 89	620 56	973 16	378 97	1,015 65
December.....	1,571 72	3,069 79	3,355 39	3,246 39	4,010 71	4,522 75	5,794 77	7,651 52	9,683 32	10,848 08	12,612 70
Totals.....	\$30,106 04	\$69,307 39	\$82,861 60	\$99,674 83	\$98,178 95	\$102,877 32	\$115,201 20	\$118,408 70	\$125,972 27	\$133,503 45	\$143,909 22
Less abatements to date.....	• • •	1,872 83	640 06	8,185 88	2,602 65	4,383 13	9,690 05	1,702 13	3,760 58	2,490 50	2,682 40
Net amounts.....	\$30,106 04	\$67,434 56	\$82,221 54	\$91,489 06	\$95,576 30	\$98,494 19	\$105,511 15	\$116,706 57	\$122,211 69	\$131,012 95	\$141,227 82



## FINANCIAL STATEMENT.

The total gross amount of bills sent to the City Treasurer for collection for this department, for the year ending Dec. 31, 1883, is as follows :—

For water rates . . . . .	\$92,219 78
metered water . . . . .	51,649 44
Total for the use of water . . . . .	<u>\$143,869 22</u>
For service pipe and laying . . . . .	\$1,872 49
meters sold . . . . .	4,456 25
sundry accounts . . . . .	6,559 40
Total for pipe, meters, &c. . . . .	<u>\$12,888 14</u>
Total charges for the year . . . . .	<u>\$156,757 36</u>

The following statement exhibits the receipts and expenditures for the year, the net cost of the Water Works, including the interest on the Water Loan, and all expenses in excess of receipts for water rates; also the net cost and expenses of the Works by taxation:

Net cost of the Water Works to January 1, 1883, as per last Annual Report . . . . .	\$2,323,048 97
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EXPENDED DURING THE YEAR FOR WATER-PIPES AND  
FOR LAYING THE SAME, AND ALL OTHER ITEMS OF  
CONSTRUCTION.

## MATERIALS FOR MAINS, SERVICES, &amp;c. :—

Cast-iron pipe and specials . . . . .	\$14,409 30
Wrought-iron pipe and fittings . . . . .	3,017 96
Brass connections . . . . .	521 53
Lead, lead pipe . . . . .	598 47
Teaming pipe . . . . .	470 12
Pipe and service joints, hardware, powder, fuse, &c. . . . .	545 97
Freights . . . . .	1,412 94
<i>Amounts carried forward,</i>	<u>\$20,976 29 2,323,048 97</u>

## REPORT OF THE WATER BOARD.

13

<i>Amounts brought forward,</i>	\$20,976 29	2,323,048 97
Lumber . . . . .	208 96	
Valves and cocks . . . . .	441 93	
Hydrants . . . . .	920 37	
Hydrant covers, frames and boxes . . . . .	290 40	
Labor on same . . . . .	14 75	
Packing . . . . .	101 00	
Gates for mains . . . . .	242 65	
Gate boxes . . . . .	149 52	
Service caps . . . . .	32 15	
Paving, labor . . . . .	37 99	
	<u>\$23,411 01</u>	
Labor, pay-roll on acct. of—		
Extensions . . . . .	\$3,769 86	
Services . . . . .	2,397 80	
Piping . . . . .	839 54	
Teaming . . . . .	630 00	
	<u>\$7,637 20</u>	
Total construction account . . . . .	<u>\$31,048 21</u>	

## MAINTENANCE.

## EXPENDED FOR REPAIRS, CURRENT EXPENSES,

## PUMPING, &amp;C., VIZ. :—

## REPAIRS.

Labor, pay-roll . . . . .	\$3,701 40
Lumber . . . . .	268 66
Wrought-iron pipe and fittings . . . . .	244 84
Supplies . . . . .	219 13
Iron and steel . . . . .	126 75
Hardware, lead, &c. . . . .	155 30
Oil, fuel, &c. . . . .	12 79
Repairing drains, drinking fountains, &c. . . . .	124 85
Pump, hose and couplings . . . . .	58 42
Stone, brick, lime, sand and cement . . . . .	67 85
Total repairs . . . . .	<u>\$4,979 99</u>

*Amount carried forward,* \$2,323,048 97

*Amount brought forward,* \$2,323,018 97

CURRENT EXPENSES. Pay-roll.

Salaries . . . .	\$3,277 19	
Inspection . . . .	2,740 20	
Clerk hire . . . .	1,713 00	
Foreman . . . .	888 33	
City Engineer . . . .	216 25	
	<hr/>	\$8,834 97

Materials.

Printing, stationery, &c. . .	\$601 08	
Horse bought . . . .	125 00	
Horse keeping . . . .	324 23	
Repairs of wagon, harnesses, &c. .	248 50	
Telephone service . . . .	151 82	
Flushing sewers . . . .	141 00	
Mason work . . . .	10 20	
Analysis of water . . . .	32 40	
Filter gallery . . . .	7 50	
	<hr/>	\$1,641 73

Total current expenses . . . \$10,476 70

PUMPING ACCOUNT.

Coal . . . .	\$6,186 53
Labor, pay-roll . . . .	3,381 57
Morris engine, new bucket . .	598 05
Oil and tallow . . . .	116 59
Iron and brass castings . .	99 52
Waste and packing . . . .	42 91
Gas . . . .	49 98
Wood . . . .	25 12
Hardware, sand, cement, &c. .	16 21
Stationery and other supplies .	83 83

Total pumping account . . . \$10,600 31

RESERVOIR.

Labor, pay-roll . . . .	\$650 05
Repairs . . . .	106 90
Supplies, teaming, &c. . . .	31 79

Total reservoir account . . . \$788 74

*Amount carried forward,* \$2,323,048 97

*Amount brought forward,* \$2,223,048 97

**METER ACCOUNT.**

Meters purchased . . . . .	\$4,964 63
Labor, pay-roll . . . . .	\$2,507 18
Repairs on meters . . . . .	230 29
Teaming . . . . .	27 75
Freight paid on meters . . . . .	39 93
Supplies . . . . .	9 50
	<hr/>
	\$2,814 65
Total meter account . . . . .	<hr/>
	\$7,779 28

**RECAPITULATION.**

Total construction account . . . . .	\$31,048 21
Repairs . . . . .	\$ 4,979 99
Current expenses . . . . .	10,476 70
Pumping account . . . . .	10,600 31
Reservoir account . . . . .	788 74
Meter account . . . . .	2,814 65
	<hr/>
Total maintenance account . . . . .	\$29,660 39
Meters purchased . . . . .	4,964 63
	<hr/>
Amount expended for the year, exclusive of interest . . . . .	\$65,673 23
Interest paid during the year . . . . .	114,040 00
	<hr/>
Total expenditures for the year . . . . .	\$179,713 23
	<hr/>
	\$2,502,762 20

**CREDITS.**

Amounts received by the City Treasurer during the year for water rates, service pipe and sundries, viz. :	
For account of 1882 . . . . .	\$ 13,405 71
“ 1883 . . . . .	139,177 28
	<hr/>
Total receipts for the year . . . . .	\$152,582 99
	<hr/>
Net cost of Works, including interest on Water Loan, to January 1, 1884 . . . . .	<hr/>
	\$2,350,179 21

Present debt of the city, by bonds and notes, on account of the construction of the Water Works,	<u>\$1,875,000 00</u>
Total amount paid from the City Treasury to January 1, 1884, by taxation, on account of Water Works,	
in excess of receipts from loans and water rates,	\$475,179 21
Value of Water Works Sinking Funds, Jan. 1, 1884,	406,101 90
	<u>\$881,281 11</u>
Net cost of Works, including interest on Water Loan, to January 1, 1884 . . . . .	\$2,350,179 21
Whole amount paid by taxation, and by appropriation for the Sinking Funds, and the value of the accumulation of said Funds, January 1, 1884	881,281 11
Debt of the city on account of Water Works, in excess of Water Works Sinking Funds, Jan. 1, 1884,	<u>\$1,468,898 10</u>

The following table will show the gross cost of the Water Works, yearly, from the commencement of the same to Jan. 1, 1884 :

Expended in 1870 . . . . .	\$ 95,057 00
“ 1871 . . . . .	624,151 66
“ 1872 . . . . .	560,708 40
“ 1873 . . . . .	349,717 87
“ 1874 . . . . .	233,370 63
“ 1875 . . . . .	275,660 78
“ 1876 . . . . .	221,502 24
“ 1877 . . . . .	163,814 28
“ 1878 . . . . .	158,510 15
“ 1879 . . . . .	150,047 82
“ 1880 . . . . .	154,391 59
“ 1881 . . . . .	231,171 27
“ 1882 . . . . .	173,645 92
“ 1883 . . . . .	179,713 23
Gross cost of Works to Jan. 1, 1884 . . . . .	<u>\$3,571,462 84</u>
Receipts from various sources to Jan. 1, 1884	1,221,283 63
Net cost of Works to Jan. 1, 1884 . . . . .	<u>\$2,350,179 21</u>

The following table will show the expenditures and receipts of the Works from 1873 to 1884, exclusive of the interest on the water debt:—

	Expenditures.	Receipts.	Expenditures in excess of receipts.	Receipts in excess of expenditures.
1873	\$188,376.59	\$ 57,739.48	\$130,637.11	
1874	128,105.63	80,625.65	47,479.98	
1875	170,095.78	94,908.14	75,187.64	
1876	115,012.24	98,815.54	16,196.70	
1877	53,988.72	100,826.63		\$46,837.91
1878	49,900.15	104,142.87		54,242.72
1879	42,157.82	110,185.34		68,027.52
1880	45,031.59	123,740.49		78,708.90
*1881	121,601.27	128,053.97		6,452.70
†1882	64,525.92	140,397.96		75,872.04
1883	65,673.23	152,582.99		86,909.76

\* In 1881 there were expended the following extraordinary amounts:

For river crossing, 24-inch reserve line . . . . \$ 9,988 59  
 high service water supply . . . . . 57,969 39

† In 1882 " " . . . . . 10,898 59

Had these extraordinary expenses not occurred, the excess of receipts over expenditures for those years would have been respectively \$74,410.68 and \$86,770.63, substantially.



Members of the Water Board, together with members of the Joint Committee of the City Council on Fire Department, and the Engineers of both departments, had the great pleasure of accepting an invitation extended to them to attend the meeting of the New England Water Works Association at Pawtucket, R. I., Sept. 19, 1883. This Association is composed of Superintendents, Registrars, Secretaries, Treasurers, and Engineers of the various Water Works in New England, and is formed "for the exchange of information pertaining to the management of Water Works, for the mutual benefit of consumers and Water Companies, and for the purpose of securing economy and uniformity in the operation of Water Works," in the language of the Preamble to their Constitution and By-Laws. At the meetings various topics relating to the care and management of Water Works are discussed, and much valuable information relating thereto is given. The Association now has a membership of one hundred and twenty-eight. At the meeting held at Pawtucket the members were shown the many interesting points in connection with the Pawtucket Water Works, including the Distributing Reservoir, the new and old Pumping Stations, and later were entertained at the rooms of the Business Men's Association — an organization composed of the wide-awake business men of that energetic town — with a substantial collation, at the conclusion of which the party proceeded to Wilkinson's Park, where a fine exhibition of fire streams was made, under the direction of Chief Engineer Collyer of the Pawtucket Fire Department. The Association was then escorted by the entire Fire

Department to the steamer Pioneer, and then conveyed down the beautiful Pawtucket and Providence Rivers to the grounds of the Vue de l'Eau Club, where the proverbial Rhode Island hospitality was bountifully exemplified.

At the second annual meeting of the Association, held in Worcester, Mass., June 21, 1883, an invitation was extended to the Association, by Mr. Holden, our Superintendent, to hold the third annual meeting in this city on Thursday and Friday, June 19th and 20th of the present year. This invitation was accepted, and Lowell will have the honor and pleasure of entertaining this important Association at that time. The Water Board bespeak the kind co-operation of the City Council in rendering the visit one of pleasure and profit. At the meeting the following topics have been named for discussion, viz.: —

1st. Service Pipes, Material, Size, &c.—the discussion to be opened by a paper to be presented by W. H. Richards, Superintendent of the New London (Conn.) Works.

2d. Filtration of Water—the discussion to be opened by a paper to be presented by H. W. Rogers, Superintendent of the Lawrence (Mass.) Works.

During the past year the Works have suffered a great loss in the death of Daniel D. Frazer, who for several years past had faithfully filled the responsible position of Foreman of the Works. Mr. Frazer had been connected with this Department since the commencement of the Water Works, in various positions, in all of which he displayed remarkable energy and judgment, and was always faithful in the performance



of every duty committed to his care;—ready at all times, by night or day, to devote himself thoroughly to the work allotted him. He died March 30th, and the large attendance of friends, even outside his immediate associates upon the Works, at the obsequies, which occurred April 1st, testified in the strongest manner to the high regard and esteem in which he was held in our community.

We refer, in conclusion, to the Reports of the Superintendent and City Engineer, accompanying our Report, for much interesting and valuable information concerning the work accomplished during the past year, and trust that in the future, as in the past, this important department, so necessary for a successful municipality, may continue to receive your most thoughtful consideration and care.

Respectfully submitted.

A. A. HAGGETT,  
CHAS. C. HUTCHINSON,  
GEO. W. FIFIELD,  
EDWARD B. PEIRCE,  
JOHN J. HOGAN,

*Members of the Lowell Water Board.*





**ELEVENTH ANNUAL REPORT**  
**OF THE**  
**CITY ENGINEER TO THE WATER BOARD.**

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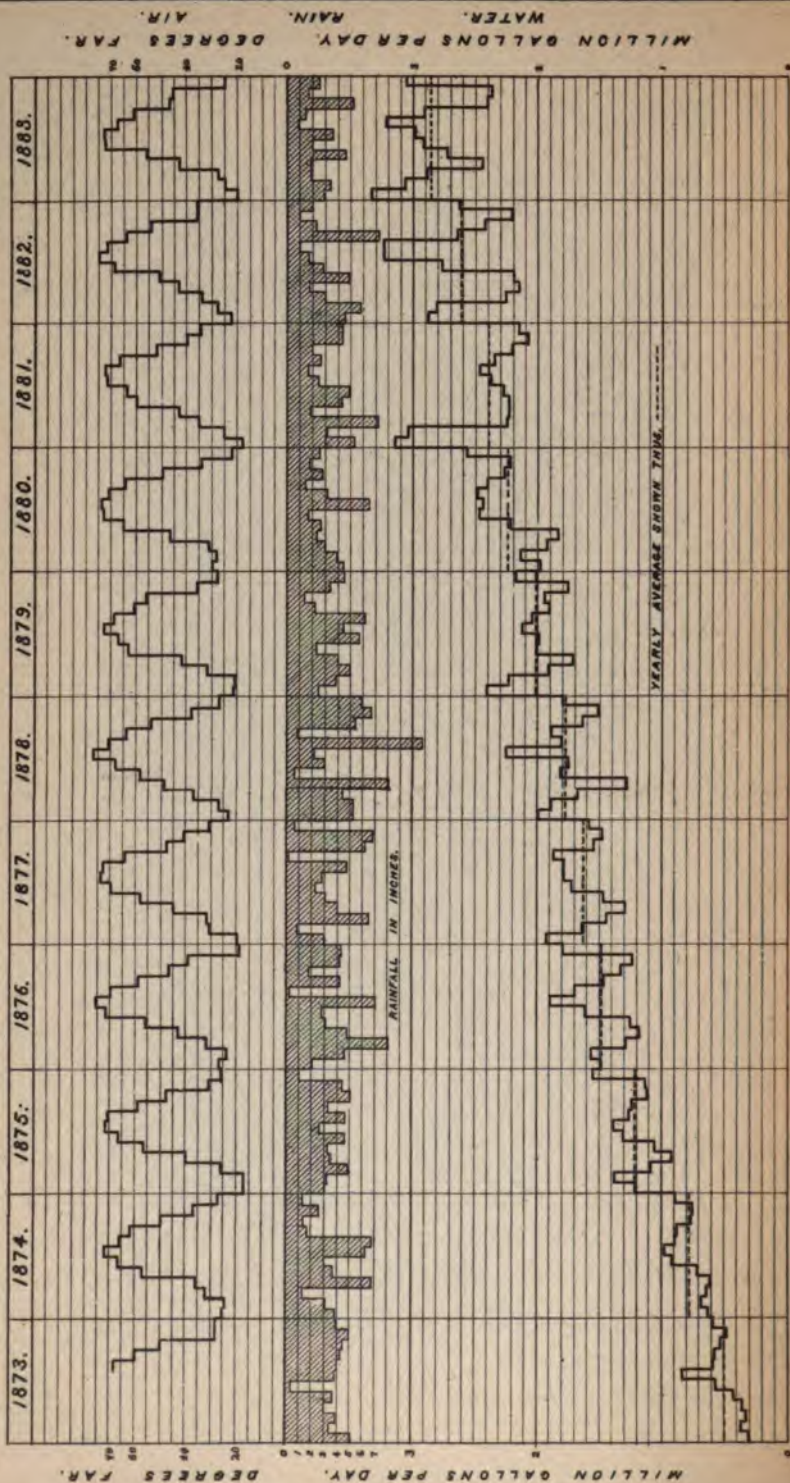
**JANUARY 1, 1884.**





# LOWELL WATER WORKS.

DIAGRAM SHOWING AVERAGE DAILY TEMPERATURE, AND CONSUMPTION OF WATER FOR EACH MONTH FROM JANUARY 1873 TO JANUARY 1884. ALSO RAINFALL AT PAWTUCKET DAM AS RECORDED BY THE PROPRIETORS OF THE LOCKS AND CANALS ON MERRIMACK RIVER.



# REPORT OF THE ENGINEER.

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OFFICE OF CITY ENGINEER,  
LOWELL, MASS., Jan. 1, 1884.

## *To the Lowell Water Board:*

GENTLEMEN—The undersigned respectfully submits the Eleventh Annual Report of the work done by the pumping-engines at the Pumping-Station, calculated from the records kept by Mr. James P. Roberts, the Engineer in charge.

No "duty" has been calculated for the high-service engine, because it takes the steam from the same boilers and at the same time the other engines are pumping, and the coal used can only be approximately ascertained. The cost of pumping one million gallons of water from the low-service reservoir to the high-service reservoir, is about eleven dollars and forty-eight cents, which added to the cost of raising the same quantity into the low-service reservoir, makes the total cost of raising one million gallons into the high-service reservoir, approximately, twenty dollars and fifty-one cents.

It has often been remarked that the old reservoir ought to have been located where the high-service reservoir is built. If it had been, and all the water raised to that height, the cost of pumping this year would be \$13,804.06, instead of \$9,629.25; and the



proportion used in the high-service district is less than one-fiftieth of the total consumption. This seems to prove the practical economy and wisdom of the present locations of the reservoirs.

The accompanying diagram, which shows the yearly rain-fall, was made from data kindly furnished me by James B. Francis, Agent of the Locks and Canals Company, from their record taken at the Pawtucket dam. It would make quite a valuable addition to the records if a rain-gauge be placed at the Beacon-Street reservoir, which could be kept by the keeper.

Table showing work done with Morris Engine (Beam and Fly-Wheel) and Boilers, for each month during the year 1883.

MONTHS.	No. of days' pump- ing.	Av'e No. of hours' pump'g per day.	No. of hours' pump'g per month.	No. of strokes made per month.	Av'e No. of strokes made per minute.	Average head, includ- ing friction, in feet.	Quantity pumped per month, in U. S. gallons.	Average quan- tity pumped in U. S. gallons, per day, in U. S. gallons.	No. gallons of water raised in U. S. to reservoir per lb., of total coal consumed.	Duty in lbs. 1 foot high, with 100 lbs. coal, used in pumping only, no deduction for ashes or clinkers.	Duty on total coal consumed, no deduction for ashes or clinkers.
January . . .	31	12-56	401-05	288,240	11.97	168.8	92,230,800	2,973,380	548	90,530,116	77,176,475
February . . .	23	13-33	311-45	218,380	11.67	166.1	69,881,600	3,038,330	547	88,423,684	75,602,880
March . . . .	31	12-41	293-10	285,600	12.11	166.2	91,392,000	2,948,129	555	90,510,541	76,878,446
April . . . . .	1	12-40	12-40	8,943	11.76	166.0	2,861,760	2,861,760	530	89,979,192	73,316,376
May . . . . .	2	8-35	17-10	11,609	11.27	166.1	3,714,880	1,857,440	554	93,498,608	76,752,589
June . . . . .	9	14-34	131-10	91,653	11.65	166.7	29,328,960	3,238,773	555	83,581,693	77,097,590
July . . . . .	25	16-47	419-45	284,718	11.30	167.0	91,109,760	3,644,390	568	86,491,074	79,050,285
August . . . .	28	16-12	453-55	315,953	11.60	167.9	101,104,960	3,610,891	578	87,195,075	80,911,656
September . .	22	16-15	357-40	254,139	11.84	168.3	81,324,480	3,696,567	571	88,485,529	80,153,683
October . . . .	28	11-42	327-35	234,166	11.92	166.2	74,933,120	2,676,183	553	92,291,169	76,620,894
November . . .	25	12-22	309-10	220,890	11.91	165.8	70,684,800	2,827,392	571	95,102,880	78,957,683
December . . .	29	13-35	394-15	297,254	12.57	166.1	95,121,280	3,280,044	578	98,518,614	80,093,812
Totals and av'ges.	254	13-29	3,529-20	2,511,545	11.86	166.8	803,694,400	3,164,151	563	89,739,070	78,309,950

Table showing work done with Worthington Duplex Engine and Boilers, for each month during the year 1883.

MONTHS.	No. of days' pumping.	Av'e No. of hours' pumping per day.	No. of hours' pumping per month.	No. of strokes made per month.	Av'e No. of strokes made per minute.	Average head including friction, in feet.	Quantity pumped per month, in U. S. gallons.	Average quantity pumped daily, in U. S. gallons.	No. gallons of water raised in reservoir per lb. of total coal consumed.	Duty in lbs. 1 foot high, with 100 lbs. coal used in pumping only, no deduction for ashes or clinkers.	Duty on total coal consumed, no deduction for ashes or clinkers.
January . . .	7	10-19	72-15	34,338	7.92	173.14	10,644,780	1,530,683	423	73,467,072	61,170,341
February . . .	5	13-03	65-15	49,035	12.52	163.30	15,200,850	3,040,170	448	69,165,763	61,007,015
March . . . .											
April . . . .	24	12-13	293-05	217,922	12.39	163.30	67,555,820	2,814,826	438	68,432,867	59,642,924
May . . . .	30	12-03	361-15	257,939	11.90	164.63	79,961,090	2,665,369	444	70,602,175	61,020,491
June . . . .	24	11-40	279-55	194,022	11.55	165.30	60,146,820	2,506,117	442	66,467,905	60,898,775
July . . . .											
August . . . .											
September . .	2	12-13	24-25	17,054	11.64	166.10	5,286,740	2,643,370	457	73,550,895	63,362,026
October . . .											
November . .											
December . .											
Totals and ave'gs	92	11-55	1,096-10	770,310	11.71	165.96	238,796,100	2,595,610	441	69,518,048	61,108,732

*Table showing amount of coal, etc., used for Morris Engine at Pumping Station, during the year 1883.*

MONTHS.	COAL CONSUMED.			
	For starting fires, in lbs.	When pumping, in lbs.	For banking fires, in lbs.	Total coal con- sumed.
January . .	18,600	143,330	6,200	168,130
February . .	13,800	109,400	4,600	127,800
March . . .	18,600	139,860	6,200	164,660
April . . .	800	4,400	200	5,400
May . . .	900	5,500	300	6,700
June . . .	3,000	48,750	1,100	52,850
July . . .	9,600	146,610	4,200	160,410
August . .	9,000	162,250	3,600	174,850
September .	9,000	128,910	4,400	142,310
October . .	16,800	112,460	6,200	135,460
November .	15,000	102,700	6,000	123,700
December .	17,400	140,800	6,200	164,400
Totals . .	132,500	1,244,970	49,200	1,426,670

*Table showing amount of coal, etc., used for the Worthington Duplex Engine, at Pumping Station, for each month during the year 1883.*

MONTHS.	COAL CONSUMED.			
	For starting fires, in lbs.	When pumping, in lbs.	For banking fires, in lbs.	Total coal con- sumed.
January . .	3,300	20,910	900	25,110
February . .	3,000	29,910	1,000	33,910
March . . .				
April . . .	14,400	134,350	5,400	154,150
May . . .	18,000	153,390	6,400	179,790
June . . .	8,100	124,660	3,300	136,060
July . . .				
August . .				
September .	1,200	9,950	400	11,550
October . .				
November .				
December .				
Totals . .	48,000	475,170	17,400	540,570

Table Showing work done with Worthington High-Service Engine.

MONTHS.	No. of days pumping.	Average No. of hours pumping per day.	No. of hours pumping per month.	No. of strokes made per month.	Average No. of strokes per minute.	Average head, including friction in feet.	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. gallons.	No. of gals. of water pumped into reservoir per lb. of total coal consumed.	Coal in pounds used when pumping.
January . .	4	10-32	42-10	94,973	37.53	79.12	1,329,622	332,405	347	3,830
February . .	3	12-18	36-55	73,945	33.38	78.05	1,035,230	345,077	403	2,570
March . .	3	10-35	31-45	68,011	35.70	78.54	952,154	317,385	399	2,385
April . .	3	10-48	32-25	59,428	30.55	76.23	831,992	277,331	378	2,200
May . .	6	11-14	67-25	115,918	28.65	78.59	1,622,852	270,475	368	4,400
June . .	8	10-07	81-00	146,373	30.12	78.67	2,049,222	256,153	372	5,510
July . .	8	11-15	90-00	145,299	26.91	78.48	2,034,186	254,273	344	5,900
August . .	10	11-37	116-10	169,959	24.38	78.87	2,379,426	237,942	307	7,750
September . .	9	10-03	90-30	172,874	31.83	78.15	2,430,336	268,915	315	7,670
October . .	6	9-35	57-30	115,027	33.34	77.63	1,610,378	268,396	319	5,040
November . .	3	10-20	31-00	71,872	38.64	78.15	1,006,208	335,402	336	2,990
December . .	6	8-10	49-00	104,734	35.62	76.39	1,466,276	244,379	316	4,630
Tot's and av's.	69	10-31	725-50	1,338,413	30.73	78.07	18,737,782	271,562	350	54,875

## PUMPING STATION, MORRIS ENGINE.

*Running Expenses for the year 1883.*

Pay of engineer and firemen . . . . .	\$2,298 61
236 $\frac{500}{1000}$ tons coal, (Powelton) 1882, at \$5.37 . . . . .	1,269 17
476 $\frac{2333}{1000}$ tons coal, (Powelton) at \$4.99 . . . . .	2,380 18
1 $\frac{3}{8}$ cords wood, at \$4.00 . . . . .	5 50
Gas for lighting works . . . . .	36 38
311 lbs. tallow, at 9 $\frac{1}{2}$ c. . . . .	29 54
64 gallons mixed oil . . . . .	38 75
28 $\frac{1}{2}$ gallons cylinder oil . . . . .	21 56
50 $\frac{1}{2}$ gallons crude oil, at 22c. . . . .	11 11
103 lbs. cotton waste, at 12 $\frac{1}{2}$ c. . . . .	12 88
55 $\frac{1}{2}$ lbs. soapstone packing, at 30c. . . . .	16 65
6 lbs. hemp packing, at 35c. . . . .	2 10
4 $\frac{1}{4}$ lbs. asbestos packing . . . . .	1 25
Repairs on engine and pump . . . . .	675 53
Repairs on boilers . . . . .	20 99
Sundries . . . . .	48 55
<b>Total . . . . .</b>	<b>\$6,868 75</b>

Cost of raising water into reservoir, per million gallons,	\$8 55
Cost of raising water one foot high, per million gallons,	.05 $\frac{12}{100}$

## WORTHINGTON ENGINE.

*Running Expenses for the year 1883.*

Pay of engineer and firemen . . . . .	\$1,014 69
257 $\frac{720}{1000}$ tons coal, (Powelton) 1882, at \$5.37 . . . . .	1,382 02
121 $\frac{833}{1000}$ tons coal, (Powelton) at \$4.99 . . . . .	64 50
1 cord wood, at \$4.00 . . . . .	4 00
Gas for lighting works . . . . .	13 45
33 gallons cylinder oil . . . . .	24 94
50 lbs. cotton waste, at 12 $\frac{1}{2}$ c. . . . .	6 25
26 lbs. soapstone packing, at 30c. . . . .	7 80
Repairs on engine and pump . . . . .	4 50
Repairs on boilers . . . . .	8 99
Sundries . . . . .	14 17
<b>Total . . . . .</b>	<b>\$2,545 31</b>

Cost of raising water into reservoir, per million gallons,	\$10 66
Cost of raising water one foot high, per million gallons,	.06 $\frac{43}{100}$

## RESERVOIR, 1883.

The following table shows the average depth of water, the number of gallons, and the temperature of the water in the reservoir, and also the temperature of the air for each month. The temperature of the water was taken at 6 A. M. and 6 P. M., and of the air at 6 A. M., 1 and 6 P. M.

MONTHS.	Depth in feet.	Quantity in U. S. gallons.	Temperature in degrees.	
			Of water.	Of air.
January . . . . .	19.40	29,565,600	33.0	19.9
February . . . . .	19.73	30,129,100	33.0	24.7
March . . . . .	20.15	30,830,100	33.8	27.4
April . . . . .	19.60	29,902,400	40.0	43.2
May . . . . .	19.05	28,979,600	54.2	56.2
June . . . . .	18.73	28,437,600	64.4	72.5
July . . . . .	19.10	29,063,200	64.8	73.3
August . . . . .	18.60	28,257,400	69.2	69.1
September . . . . .	18.60	28,257,400	64.6	60.1
October . . . . .	19.30	29,405,000	56.7	46.8
November . . . . .	19.50	29,733,700	45.3	42.4
December . . . . .	19.30	29,405,000	36.1	25.2

The following table shows the average monthly and daily consumption of water for the year 1883.

MONTHS.	Gallons per month.	Gallons per day.
January . . . . .	103,591,210	3,341,650
February . . . . .	85,929,340	3,068,900
March . . . . .	89,693,120	2,893,330
April . . . . .	73,098,070	2,436,800
May . . . . .	84,650,690	2,730,670
June . . . . .	87,237,710	2,907,920
July . . . . .	92,652,300	2,988,780
August . . . . .	99,844,150	3,220,780
September . . . . .	87,313,080	2,910,440
October . . . . .	74,652,800	2,408,160
November . . . . .	71,244,880	2,374,830
December . . . . .	94,981,470	3,063,920
Total and average.	1,044,888,829	2,862,710

Respectfully submitted.

GEO. E. EVANS, *City Engineer.*



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**ELEVENTH ANNUAL REPORT**  
**OF THE**  
**SUPERINTENDENT OF WATER WORKS,**  
**TO THE**  
**LOWELL WATER BOARD.**

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**JANUARY 1, 1884.**



## REPORT OF THE SUPERINTENDENT.

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SUPERINTENDENT'S OFFICE, CITY HALL.

LOWELL, January 1, 1884.

### *To the Lowell Water Board:*

GENTLEMEN — In accordance with the requirements of the city ordinance I respectfully submit herewith the eleventh annual report of the Superintendent of the Lowell Water Works for the year ending December 31st, 1883.

The total amount of water pumped during the year is 1,042,490,500 gallons, making an average amount used per day for each inhabitant of 40.8 gallons. This includes all the water used for manufacturing purposes, street fountains, extinguishing fires, sprinkling streets, &c. The total amount of water sold by meter measurement is 260,225,000 gallons. During the year an unusual amount of labor has been expended on repairs, especially on street-gate boxes, flush hydrant boxes, and service boxes. Many of these wooden boxes have now been in the ground over eleven years, and being subjected to the action of damp earth on the outside, and dead air on the inside, it has caused them to decay more rapidly than would be done under ordinary circumstances.

Oct. 19th, accompanied by the president of the Water Board and the City Engineer, the annual inspection of the filter gallery was made. The masonry was all in good condition, and there was no perceptible increase of sediment in the gallery.

Nov. 9th, the 24-inch man-hole cover at the Beaver Brook crossing was taken off, and a full head of water allowed to run through it for six hours, washing the whole conduit perfectly clean.

#### PUMPING STATION.

At the pumping station the Morris engine has pumped 803,694,400 gallons, and the Worthington has pumped 238,796,100 gallons of water. A section of the force main under the Morris pump on the straight line leading from the curve, having been cracked for some time, caused by the continual jar of the pump, was taken out April 2nd, and replaced by a wrought iron pipe with curved flanges at each end. The spring of these flanges takes off the jar from the pump so that no more difficulty need be apprehended. The cast iron reducing piece, four feet to two feet, which connects the air column to the quarter turn on the curve, having been cracked and patched for several years, has now been replaced by a wrought iron one, which was made for that purpose at the time the crack was first discovered.

The new ring which was riveted to the pump-bucket last year, after running about twelve months, was found to be broken in several places, caused probably by the spring of the bucket. It was then thought advisable to have a heavier bucket made. The new bucket was cast by Downes & Cook, at the Atlantic Works, East Boston, and was finished up at the Lowell Machine Shop. The rim is seven-eighths of an inch thick, has ten wings, and weighs 1,635 lbs., while the old bucket was three-eighths of an inch thick, with eight wings, and weighed 1,293 lbs. The pump now runs much

steadier than it ever has before. The cast iron cut-off cam, which had been in use ever since the Morris engine was first set up, was worn so much on the side which takes steam, and also on the side which cuts off, that it caused the engine to be behind time in taking steam, and also in cutting off. This cam has now been taken off and turned down to a smooth cylinder. Then two pieces of bell metal, cast to a proper shape, were bolted on to the cylinder, forming cams, so that now the engine takes steam and cuts off, at the proper time, regulating much closer, and makes a saving of about fifty lbs. of coal for each million of gallons pumped.

New screens have been put into the pump well. The space beneath the force main leading from the pump has been filled up with masonry, and the main pipe braced with four inch iron beams, thereby taking off the strain to the pipe caused by the working of the pump.

#### HIGH SERVICE.

During the year 18,737,782 gallons of water were pumped into the high-service reservoir. There has been no extension of cast iron mains on this division, but a 1½ inch wrought iron pipe has been laid from Beacon Street, through Reservoir Street and Llewellyn Street, supplying water to four houses. In Belvidere there are 37 houses and one fountain, and in Centralville there are 69 houses, six stables and one fountain now supplied with water from the high service system.

#### EXTENSIONS.

17,155 feet of cast iron main pipe have been laid this year, being an increase of 4000½ feet more than were laid last year. The longest main line was laid on



Chelmsford Street, consisting of 1428 feet of 12-inch pipe, forming a direct supply to feed the whole of that section of the city.

#### LEAKS.

There have been two leaks in joints of force main. Two 8-inch pipes and one 12-inch main have broken off on account of settling of the earth above the Interceptional sewer. Two leaks in joints of main pipe, one leak caused by an 8-inch cap blowing off, and one 8-inch main on the high-service on Mansur Street, split the whole length. Twenty-seven service pipes have broken off, most of them occasioned by the settling of sewer trenches.

#### HYDRANTS.

There have been sixteen post hydrants set on extensions, and one hydrant set on Middlesex street, opposite the Cutter & Walker suspender factory. Changes of old hydrants for new have been made as follows: One on Middlesex Street, near Garnet Street, two on Merrimack Street, between Suffolk Street and Cabot Street, one on Cabot Street, near Salem Street, and eight on Adams Street. The old hydrant on Appleton street, near Gorham Street, and the flush hydrant on Hurd Street, about 100 feet from Central Street, have been taken out and discontinued. The Pattee & Perkins hydrant, which was formerly on Grand Street, has been set on Brooks Street, and the Chapman Valve Co's hydrant, which was formerly on Merrimack Street, opposite Central Street, has been set at the junction of West Sixth and West Street, taking the place of a Boston Machine Co's hydrant, which was cracked.

## FIRE SERVICES.

A 6-inch fire service has been laid on Sherman Street, from Lawrence Street to the Stirling Mills. Four-inch fire services have been put into R. C. Kendall & Co.'s mill on Lawrence Street, and the Lamson Cash Carrier Co.'s factory on Walker Street. A 6-inch gate has been set on Tremont Street, near Hall Street, and connects with a 6-inch pipe which runs into the yard of the Lawrence Manufacturing Company; and the 6-inch gate which was set last year for the Lawrence Manufacturing Company on Cooledge Street, near Hall Street, has been changed for an 8-inch gate.

## METERS.

There are now 1246 meters in use, of which 167 were set during the past year. Six Ball & Fitts meters, and 53 Fitts rotaries, having become worn so much that accurate registration could not be obtained, have been taken out and replaced by other kinds. Seventy Desper meters, 47 Worthington, and 2 Ball and Fitts meters have been taken out for repairs and then reset. Six Despers and one Worthington have been destroyed by freezing, and 160 Despers have required new spindle packings. The kind and sizes of meters are shown by the following:—



TABLE OF METERS IN USE DEC. 31, 1883.

KINDS.	$\frac{1}{2}$ in.	$\frac{3}{4}$ in.	1 in.	1 $\frac{1}{2}$ in.	2 in.	3 in.	4 in.		Totals.
Desper . . . . .	481	122	63	1	. . . . .	. . . . .	. . . . .		667
Worthington . . . .	317	29	48	49	19	5	2	. . . . .	469
Ball & Fitts . . . .	38	16	2	1	. . . . .	. . . . .	. . . . .		57
Fitts Rotary . . . .	18	1	1	. . . . .	. . . . .	. . . . .	. . . . .		20
Crown . . . . .	10	11	6	. . . . .	. . . . .	. . . . .	. . . . .		27
Equitable . . . . .	2	1	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .		3
Boston . . . . .	. . . . .	1	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .		1
Motor Registers . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	2	2
Totals . . . . .	866	181	120	51	19	5	2	2	1246

## SERVICES.

During the year the water has been shut off from the premises of 18 water takers, for non-payment of water rates; and the number let on upon payment of the rates is 9. The whole number of services remaining shut off for non-payment is 11. Three hundred and seventy new services have been put in this year, making a total of 6653 services now laid. Of these 270 have been discontinued, and are shut off and disconnected from the main pipe. Many of the  $\frac{3}{4}$ -inch services, which have been in use since water was first introduced, have become completely filled with rust, and this year 84 have been taken out and replaced by larger services; the charges made to the owners being about sufficient to cover the cost of the new pipe and fittings, but not for labor. I find by referring to the statistical tables of American Water Works, compiled by J. J. R. Croes, C. E., of New York, that there is

no other city in America as large as Lowell, except New Haven, Conn., where wrought-iron service pipes are now used; and I would recommend for your consideration the adoption of lead services in place of wrought-iron.

#### ITEMS OF OTHER WORK DONE.

During the past year every service, street gate and hydrant has been inspected and put in good repair. The street drinking fountain on Market Street, near Dutton Street, has been removed, and a new cup and tank fountain set on Shattuck Street. Also, the fountain at Hosford Square has been taken out and replaced by a cup and tank fountain. The reservoir fence has been painted with mineral paint, and the high-service fence has been whitewashed. The floor at the terminal gate-house, being badly decayed, has been replaced by a new floor of kyanized lumber.

Advantage was taken of the unusual low state of the water in Merrimack River last summer, to examine the screen at the inlet pipe which connects the river with the inlet chamber. The wooden rack was taken out and found to be much worn, and two of the slats were broken. A new rack was made, using the old frame, but instead of wooden slats, 3-8-inch brass rods were used. This will probably last for many years. The 12-inch cement-lined pipe on Middlesex Street, between King and Garnet Streets, has been taken up and replaced by 8-inch cast-iron pipe, and a connection made with the 6-inch pipe leading from Appleton Street through Garnet Street.

In addition to the main pipes there has been laid an amount of smaller sizes, as follows:—

## SCHEDULE OF SMALL PIPE LAID.

STREETS.	$\frac{3}{4}$ inch.	1 inch.	$1\frac{1}{2}$ inch.
Canada . . . . .		35	
Christian . . . . .		146	
Daly . . . . .		38	
Erving . . . . .		120	
Fulton . . . . .		30	
Hale . . . . .		183	
Hanover . . . . .			44
Howard . . . . .		120	
Llewellyn . . . . .			1,414
Massasoit . . . . .		110	
Osgood . . . . .		51	
Poplar . . . . .		92	
Quebec . . . . .		45	
Reservoir . . . . .			490
Richardson's Avenue . . . . .		34	
Second . . . . .		38	
West Third . . . . .	99		
Totals . . . . .	99	1,042	1,948
Total amount . . . . . 3,089 feet.			

The amount of service pipe laid is as follows: —

Laid during 1883, $\frac{3}{4}$ inch . . . . .	4,624 feet.
“ “ “ 1 inch . . . . .	7,298 “
“ “ “ $1\frac{1}{2}$ inch . . . . .	739 “
“ “ “ 2 inch . . . . .	89 “
Total laid during 1883 . . . . .	12,750 “
Add amount previously laid . . . . .	247,023 “
Total amount laid . . . . .	259,773 “



## WATER TAKERS.

The whole number of water takers (which include each family, shop, store, office, and any other such place where city water is used) is estimated to be 13,800. The number of abatements made during the year is 221, to wit: —

ON ACCOUNT OF	1882.	1883.	Total.
Water . . . . .	\$360 47	\$1,379 89	\$1,740 36
Sundries . . . . .	77 46	29 76	107 22
Pipe, etc. . . . .	. . . . .	20 07	20 07
Totals . . . . .	\$437 93	\$1,429 72	\$1,867 65

## NUMBER AND KIND OF SERVICES CHANGED DURING THE YEAR

SIZE OF SERVICES CHANGED FOR		1 inch.	1½ inch.	1¾ inch.	2 inch.	Total.
37 . . . . .	¾ inch.	1,334	. . . .	. . . .	. . . .	1,334 ft.
1 . . . . .	¾ inch.	. . . .	38	. . . .	. . . .	38 "
25 . . . . .	¾ inch.	. . . .	. . . .	1,174	. . . .	1,174 "
3 . . . . .	¾ inch.	. . . .	. . . .	. . . .	124	124 "
5 . . . . .	1 inch.	. . . .	. . . .	618	. . . .	618 "
12 . . . . .	1 inch.	. . . .	. . . .	. . . .	355	355 "
1 . . . . .	1½ inch.	. . . .	. . . .	. . . .	60	60 "
84 Totals . .		1,334	38	1,792	539	3,703 ft.

In conclusion, I desire to express my thanks to the president and members of the Water Board for their courteous treatment and hearty co-operation in the management of the Works. Hoping that the future may be crowned with efficiency and increased prosperity, the above report is respectfully submitted.

HORACE G. HOLDEN, *Sup't.*

SCHEDULE No. 1.—Low Service.  
WATER PIPES LAID IN 1883.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.				
		12 in.	8 in.	6 in.	4 in.	Total.
Belmont . . .	Westford and Pine . . . .			501		501
Brooks . . .	Fletcher and Willie . . . .			4½		4½
Chelmsford . .	Cambridge and Liberty . . .	581				581
Chelmsford . .	Howard and Daly . . . .	847				847
Canton . . .	Princeton and Middlesex . . .			137		137
Cheever . . .	Tucker and Pawtucket . . . .			679		679
Conant . . .	Northerly to Nineteenth Street . . .			126½		126½
Concord . . .	Water and Rogers . . . .			175½		175½
Cosgrove . . .	Gorham easterly . . . .			634		634
Court . . . .	Extended southerly . . . .			237		237
East Merrimack	Easterly from Stackpole . . . .			483½		483½
Eleventh . . .	Easterly from Methuen . . . .				280	280
Grand . . . .	Southerly to Chelmsford . . . .				164	164
Gorham . . . .	Southerly from Edson cem. . . .			1407		1407
Hampshire . .	Northeasterly to Bridge . . . .			422		422
Hale . . . . .	Westerly from Thorndike . . . .				246	246
Harrison . . .	Southerly from Oak . . . .			149		149
Jenness . . . .	Westerly from Chelmsford . . . .			558		558
Kinsman . . .	Southerly to Chambers . . . .			199		199
Lawrence . . .	Northerly from Moore . . . .		306			306
Leverett . . .	Southerly from Washington . . . .				432	432
Main . . . . .	Northerly from Lincoln . . . .			164		164
Manchester . .	Westerly from Main . . . .				118	118
Merrill . . . .	Southerly from Taylor . . . .				193	193
Montreal . . .	Westerly from Main . . . .				203	203
Middlesex * . .	King and Garnet (relaid) . . . .		500			500

## SCHEDULE NO. 1.—LOW SERVICE.—Concluded.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.				
		12 in.	8 in.	6 in.	4 in.	Total.
Marsh . . .	School and Phillips . . . . .			293		293
Mount Hope .	Hodge and Second Avenue . . . . .			273		273
Nineteenth . .	Westerly from Conant . . . . .			44		44
Pine Hill . . .	Extended southeasterly . . . . .			112		112
Poplar . . . .	Westerly from Main . . . . .				254	254
Plain . . . . .	Westerly from Main . . . . .			194		194
Payton . . . .	Southerly from Plain . . . . .			121		121
Pawtucket . . .	Northeasterly from Cheever . . . . .			163		163
Quimby Avenue	Easterly from Chelmsford . . . . .				296	296
Ralph . . . . .	Westerly from Grand . . . . .			100		100
Royal . . . . .	Southerly from Westford . . . . .			345		345
So. Loring . . .	Southerly from Liberty . . . . .			801		801
Starbird . . . .	Northwesterly fr. Varnum Ave. . . . .			209		209
So. Whipple . .	Southerly from Griffin . . . . .			300		300
Saunders . . . .	Northerly from Middlesex . . . . .				216	216
Stevens . . . .	Southerly from Middlesex . . . . .		734			734
Varnum . . . . .	Southerly from Tenth . . . . .			440		440
West Third . . .	Westerly to Coburn . . . . .			185		185
Westford . . . .	Westerly from Robbins . . . . .		937			937
West Adams . .	Wilder and Walker . . . . .			312		312
West . . . . .	Northerly from Fulton . . . . .			108		108
Ware . . . . .	Southerly from Ralph . . . . .			20		20
West Sixth . . .	Northwesterly from West . . . . .			840		840
Wachusett . . .	Southerly from Thirteenth . . . . .			465		465
Hydrant pipe . .	. . . . .			146		146
Total in feet . . . . .		1428	2477	11348	2402	17655
* Less 12-inch wrought iron; cement relaid with iron . . . . .						500
						17155
Pipes laid previous to 1883 . . . . .						372692
						389847
Total in miles Jan. 1, 1884 . . . . .						73.83

## SCHEDULE No. 2.—Low Service.

LIST OF STOP GATES SET FOR YEAR ENDING DEC. 31, 1883.

STREETS.	LOCATION.	12	8	6	4
		in.	in.	in.	in.
Canton,	13.8 feet west from east line Canton Street; 3.5 feet north from north line Princeton Street.			1	
Cheever,	16 feet south of north line Cheever Street, on west line of Tucker Street.			1	
Chelmsford,	24 feet south from north line Chelmsford Street; 18.5 feet east from west line Howard Street.	1			
Gorham,	19.5 feet east from west line Gorham St.; 7.5 ft. south from post hydrant, at ent. Edson Cem.			1	
Hampshire,	25 feet east from west line Hampshire Street; 2 feet west from west line Bridge Street.			1	
Harrison,	28.6 feet west from east line Harrison Street; 1 foot south from south line Oak Street.			1	
Jenness,	21.5 feet south from north line Jenness Street, on south line Chelmsford Street.			1	
Lawrence,	8 feet west from east line Lawrence Street; 13.5 feet south from north line Moore Street.		1		
Marsh,	30 feet north from south line Marsh Street; 2 ft. west from west line School Street.			1	
Middlesex,	16.5 feet north from south line Middlesex Street, on westerly line Garnet Street.		1		
Mount Hope,	17 feet east from west line Mt. Hope St.; 460 ft. north from north line Riverside Street.			1	
Royal,	7.3 feet west from east line Royal Street; 2 feet south from south line Westford Street.			1	
So. Loring,	17 feet east from west line So. Loring St.; and on south line Liberty Street.			1	
Stevens,	13.5 feet east from west line Stevens Street; 3 feet south from south line Middlesex Street.		1		
Starbird,	9 ft. northeast from southwest line Starbird St.; 1.7 ft. n. west from n. west line Varnum Av.			1	
South,	14.4 feet west from east line South Street; 3 feet north from north line Summer Street.			1	
Wachusett,	14.5 feet east from west line Wachusett Street, and on south line Thirteenth Street.			1	

## SCHEDULE No. 3.—LOW SERVICE.

## LIST OF HYDRANTS SET FOR THE YEAR ENDING DEC. 31, 1883.

STREETS.	LOCATION.
Brooks,	North side, 150 feet east from Willie Street.
Chelmsford,	East side, 25 feet southerly from Grand Street.
Cosgrove,	South side, 467 feet east from Gorham Street.
E. Merrimack,	North side, 466 feet east from Stackpole Street.
Gorham,	West side, 1400 feet south from hydrant at entrance to Edson Cemetery.
Jenness,	North side, 543 feet west from Chelmsford Street.
Leverett,	East side, 216 feet south from south line Leverett Street.
Lawrence,	East side, 291 feet north from Moore Street.
Middlesex.	South side, 214 feet east from King Street.
Pawtucket,	South side, 147 feet east from Cheever Street.
So. Loring,	West side, 763 feet south from Liberty Street.
So. Whipple,	West side, 1 foot south from Barrington Street.
Stevens,	West side, 283 feet south from Middlesex Street.
Wachusett,	West side, 301 feet south from Thirteenth Street.
Ware,	West side, 7 feet south from Ralph Street.
Westford,	North side, 765 feet west from Belmont Street.
West Adams,	North side, 292 feet east from Wilder Street.

The above list are all post hydrants.



## SCHEDULE No. 4.—LOW SERVICE.

LIST OF STOP GATES SET FOR FIRE SERVICES FOR THE YEAR  
ENDING DEC. 31, 1883.

STREETS.	LOCATION.	12 in.	8 in.	6 in.	4 in.
Lawrence,*	4½ feet west from east line Lawrence St.; 290½ feet north from north line Moore Street.				1
Sherman,†	8 feet south from north line Sherman Street, on east line Lawrence Street.		1		
Tremont,‡	15.5 feet east from west line Tremont St.; 9.5 ft. northeast from northeast line Hall Street.		1		
Walker,§	3.8 feet west from east line Walker Street; 75 ft. north from north rail on N. & L. R. track.				1

\* On fire service belonging to Wamesit Power Company.

† On fire service belonging to Stirling Mills.

‡ On fire service belonging to Lawrence Manufacturing Company.

§ On fire service belonging to Lamson Cash Railway Company.

## SCHEDULE No. 5.

PROPERTY AT PIPE YARD JANUARY 1, 1884.

Diameter in inches . . . . .	4	6	8	10	12	16	20	24	30							
Lengths . . . . .	7	1	300	25	60	5	19	7	15							
Cut pieces, whole length in feet,	30	40	50		30											
Sleeves . . . . .	6	14	4	4	8	10	1	8	5							
Half Sleeves . . . . .								7	1							
Caps . . . . .	9	13	35		18	3	1	1								
Curves . . . . .	14	10	18	2	13	1	11	3	4							
Diameter in inches . . . . .	6x4	4x4	6x6	8x6	8x8	10x8	10x10	12x6	12x8	12x10	12x12	16x6	16x8	16x12	16x16	20x12
3-Ways . . . . .		3	9				1	12	3			3				
4-Ways . . . . .		1	5	6	6	1		6	2		1	1		2	1	
Reducers . . . . .	25			9	3		8	3	4					1		

**Wrought Iron Pipe.**—25 feet 2-inch, 230 feet 1½-inch, 700 feet 1-inch, 1200 feet ¾-in. **Hydrants.**—4-post, 21 old hydrants. **Stop Gates.**—4 4-inch, 26 in.

1 12-inch old with 6 feet 12-inch pipe attached. **Solder Nipples.**—124  $\frac{1}{4}$ -inch, 30  $\frac{1}{4}$ -inch, 75 1-inch union, 25 1-inch union nipples, 50  $\frac{3}{4}$ -inch, 6 2-inch, short nipples, 16  $\frac{1}{4}$ -inch, 10  $\frac{1}{4}$ -inch. **3 Ways.**—14  $1\frac{1}{4}$ -inch, 10 1-inch, 20  $\frac{3}{4}$ -inch. **4 Ways.**—121-inch, 9  $1\frac{1}{4}$ -inch, 30  $\frac{3}{4}$ -inch, 6  $1\frac{1}{4}$ x1-in. **Unions.**—50  $\frac{3}{4}$ -inch, 21-in., 200  $\frac{3}{4}$ -inch, 1  $1\frac{1}{4}$ -inch, 12  $\frac{1}{4}$ -inch, 1 2-inch. **Elbows.**—7 2-inch, 9  $1\frac{1}{4}$ -inch, 8  $1\frac{1}{4}$ -inch, 8  $1\frac{1}{4}$ x $1\frac{1}{4}$ -inch, 13  $\frac{3}{4}$ -inch. **Tees.**—2  $\frac{1}{4}$ -inch, 2  $\frac{1}{4}$ -inch. **Bushings.**—42x $1\frac{1}{4}$ -inch, 15  $1\frac{1}{4}$ -inch. **Sockets.**—18 1-inch, 37  $\frac{3}{4}$ -inch, 18 assorted. **Corporation Cocks.**—11  $\frac{3}{4}$ -inch. (for cement pipe), 9 1-inch, 13  $\frac{3}{4}$ -inch. **Stop and Waste Cocks.**—8  $\frac{3}{4}$ -inch, 8 2-inch. **Corporation Cocks.**—27 1-inch, 30  $\frac{3}{4}$ -inch, 35  $\frac{3}{4}$ -inch plugs, 20 1-in. caps, 5  $\frac{1}{4}$ -in. **Couplings.**—1000 assorted. **Worthington Meters.**—5  $\frac{1}{4}$ -inch, 1 1-inch, 2  $\frac{3}{4}$ -inch. **Desper Meters.**—2 1-inch, 3  $\frac{3}{4}$ -inch, 2  $\frac{3}{4}$ -inch. **Equitable Meters.**—11  $\frac{3}{4}$ -inch. **Duplex.**—1  $\frac{3}{4}$ -inch. **Crown.**—1  $\frac{3}{4}$ -inch. **Second Hand Meters.**—3  $\frac{3}{4}$ -inch, B. & F. 5  $\frac{3}{4}$ -inch, B. & F. 45  $\frac{3}{4}$ -inch, F. R. 14  $\frac{3}{4}$ -inch, 4 1-inch, 2  $\frac{1}{4}$ -inch, 1 2-inch. **Lead Connections.**—13  $\frac{3}{4}$ -inch (for cement pipe). **Sundries.**—5 2-inch, 17 1-inch, 21  $\frac{3}{4}$ -inch, 150 feet  $\frac{3}{4}$ -inch lead pipe, 75 feet 1-inch, 150 feet block tin wire, 2 bbls. charcoal, 6 wheelbarrows, 2 tongs for cleaning sidewalk-boxes, 20 meter indicators, 17 piston rods for meter, 1 pipe testing machine, 6 hydrant boxes, 3 second hand flush hydrants, 2 old style gate covers, 3 gate frames and covers, 11 hydrant frames, 15 hydrant covers, 6 set castings for street fountains, 85 sidewalk boxes, 3 M. feet of lumber,  $1\frac{1}{2}$  cords pine wood, 1 cord logs for blasting purposes, 2 tons hay, 3000 lbs. carrots, 3 horse blankets, 1 canvas horse cover, 2 horses, 2 set harnesses, 120 feet drain pipe, 40 pick handles, 9 crowbars, 60 feet rubber hose, 1 hose reel, 2 brass goose necks for hydrants, 2 brass reducers, 2 portable closets, 15 lanterns, 1 gross lamp wicks, 8 hand-saws, 2 buck-saws, 1 saw-horse, 30 calking-sets, 5 nail hammers, 10 striking hammers, 3 paving hammers, 2 stone hammers, 6 hand hammers, 250 sidewalk caps, 4 pair rubber boots, 200 feet canvas hose, 30 iron lug-straps, 250 lbs. bolts, 7 rubber hydrant packings, 2 sprinkling pots, 8 assorted files, 12 assorted gravel screens, 5 hanging irons for bridges, 2 3-feet screws, 1 machine for cement lining pipe, 10 iron bands for pipe, 2 lbs. cotton waste, 300 lbs. iron, 2 hydrant dippers with chain, 1 grind stone, 1 set blacksmith tools, 6 screwdrivers, 10 iron washers, 30 lbs. assorted nuts, 100 lbs. brass hinges, 3 hand hatchets, 2 axes, 4 trowels, 800 lbs. steel in drills, 6 scrapers for blasting purposes, 8 pipe wedges, 2 yarning irons, 2 ratchet cutters, 4 pipe cutters, 4 pipe vises, 3 lead ladles, 5 sling ropes, 15 dies, 2 ratchet die plates, 3 die plates, 14 pipe tongs, 4 iron rakes, 6 square point shovels, 8 wood plugs for main pipe, 5 lbs. shims and wedges, 1 2-inch auger, 2  $\frac{1}{4}$ -inch taps, 2 1-inch taps, 2  $\frac{3}{4}$ -inch taps, 1  $\frac{1}{4}$ -inch tap, 5 oil cans, 6 bottoms for Worthington meters, 4 lbs. sealing-wax, 1 box crayons,  $\frac{1}{2}$  box wax candles, 1 fall rope, 1 tag rope, 2 framing squares, 1 tamping iron bar, 2 wheels for stop-gate, 19 assorted gate screws, 1 root axe, 1 dualin pot, 400 iron rods, 1 10-gallon can, 3 set packing patterns, 5 lbs. leather, wire brush, 2 oil pans, 1 oil brush, 1 brass lantern, 2 brass lamps, 125 feet block tin tubing, 1 solder pot and mould, 1 pair pliers, 1 pair cut nippers, 25 hard packings for meters, 10 valve and valve seats, 1 roll packing paper, 200 lbs. old brass, 32 spindles to Worthington meter, 3 taping machines, 1 leather tool bag, 1 tin match safe, 2 rubber connections, 1 fore plane, 3 solder furnaces, 2 ironwood mallets, 3 solder irons, 1 press drill, 4 washer cutters, 1 set steel numbers, 1 lathe dog, 1 foot lathe, 1 universal chuck, 1 brass faucet, 30 brass seals, 2 sieves, 1 iron bucket for testing meters, 1 bit stock, 3 bits, 10 ends to Worthington meter, 1 surface plate, 1 5-gallon can, 1 2-gallon, 2 1-gallon, 2  $\frac{1}{2}$ -gallon, 4 1-quart, 1 4-quart wood measure, 1 tin tunnel, 2 desks, 1 grain box, 2 surcingles, 2 halters, 2 pungs, 1 keg blasting powder, 6 hammer handles, 1 16-foot straight edge, 9 steel points, 400 lbs. lead, 3 set blocks, 3 shear poles, 4 tool boxes, 6 iron sidewalk boxes, 4 lead pots, 2 furnaces, 11 work benches, 1 large map of main pipe, 1 ten-foot ladder, 1 coal stove, 1 coal hod, 1 zinc pump, 1 Edison patent pump, 2 copper force pumps, 1 counter scale, 1 platform scale, 4 brooms, 4 chairs, 1 apparatus for testing meters, 12 iron brackets, 1 keg 10d. nails, 1 keg 20d. nails, 2 wagon wrenches, 36 assorted, 12 monkey, 4 stilson, 8 ram-



mers, 3 paving mauls, 35 shovels, 75 picks, 3 hoes, 8 draught chains, 1 bbl. cement, 1 bbl. white clay, 2 snow shovels, 4 horse brushes, 1 duster, 2 hay forks, 5 manure forks, 2 wagon jacks, 1 work shop, 1 carriage shop, 1 stable, 1 store shed.

#### **Tools at Filter Inlet.**

2 iron-tooth rakes, 11 shovels, 1 rammer, 1 axe, 2 ice chisels, 1 gate wrench, 1 nail hammer, 1 pick, 2 brooms, 1 wheelbarrow.

#### **Tools at Reservoir.**

1 grindstone, 1 iron rake, 2 forks, 4 shovels, 1 sod cutter, 1 axe, 2 hoes, 2 scythes, 2 snaths, 1 grass hook, 1 wheelbarrow, 1 coil rope, 2 thermometers, 1 snow shovel, 1 harrow plough, 1 stop-gate wrench, 1 sidewalk wrench, 1 ladder, 3 gallons japan, 1 bbl. linseed oil, 1 bbl. cement, 1 paint brush, 3 paint pots.

#### **Property and Tools at Engine House.**

1 vise, 1 work bench, 1 portable forge, 8 sets brasses for engine, 2 sets differential blocks, 1 piece 2-inch rope, 1 set fire irons, 1 brass hydrant, 3 axes, 11 wrenches, 1 hand-saw, 2 jack-screws, 2 cold chisels, 1 ratchet drill, 1 socket-drill, 3 calking chisels, 1 barometer, 2 thermometers, 1 desk, 1 indicator, 1 oil cupboard, 2 oil dishes, 1 platform scale, 4 crowbars, 64 feet  $\frac{5}{8}$ -inch chain, 16 eyebolts, 1 truck, 1 key wrench for air pump, 1 iron wheelbarrow, 2 hand-saws, 1 buck-saw, 1 saw-horse, 2 gas lamps, 1 high grade thermometer, 4 brass bolts,  $\frac{1}{2}$ -inch diameter for pump valves, 5 spare pump valves, 5 sets spare weights for valves, 11 socket wrenches, Morris engine, 11 finished wrenches Worthington engine, 3 sledge hammers, 10 drills, 1 black walnut cabinet, 8 chairs, 2 lengths hose, 2 copper lamps, 100 bolts, assorted sizes, 2 bit-stocks, 3 bits, 1 25-foot ladder, 1 20-foot, 1 8-foot ladder, 1 pair steps, 1 hoe, 2 racks, 1 small die plate, 1 fore-plane, 3 monkey wrenches, 100 feet 2-inch rope, 4 chisel bars, 6 small taps, 4 finished socket wrenches Worthington engine, 1 14-quart iron pail, 4 hand hammers, 1 grind stone, 1 anvil, 1 clock, 7 pairs gas tongs, 1 wrench, 11 finished do.

#### **Property in Water Board and Superintendent's Office.**

16 chairs, 2 high stools, 1 letter press, 5 desks with drawers, 3 standing desks, 2 office tables, 1 book-case, 1 clock, 5 ink stands, 1 tumbler, 4 maps of Lowell, 1 map of water-distributing pipes, 3 waste baskets, 3 mats, 3 hat-racks, 3 spittoons, 4 wrenches, 1 pick, 1 steel bar, 1 tin match safe, 1 lantern, 1 water gauge, 1 apparatus for sealing gates, 2 screw drivers, 2 monkey wrenches, 1 safe, 1 key-rack, 1 shovel, 1 atlas of Lowell, 1 atlas of Middlesex County, 1 black-walnut book-case, 1 apparatus for testing capacity of engine.

TWELFTH  
ANNUAL REPORT  
OF THE  
★  
Lowell Water Board  
TO THE  
CITY COUNCIL

ACCOMPANIED BY THE REPORTS OF THE CITY ENGINEER AND OF  
THE SUPERINTENDENT OF WATER WORKS, TO THE  
WATER BOARD.

JANUARY 12, 1885.



LOWELL, MASS.  
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1885.

42852

1885

## CITY OF LOWELL.

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IN COMMON COUNCIL, JAN. 13, 1885.

Read and sent to the Board of Alderman.

DAVID CHASE, *Clerk*.

---

IN BOARD OF ALDERMEN, JAN. 13, 1885.

Read and ordered placed on file.

SAMUEL M. CHASE, *City Clerk*.

# CIVIL ORGANIZATION, LOWELL WATER WORKS

From their commencement to Jan. 1, 1885.

## JOINT SPECIAL COMMITTEES.

1869.

Jonathan P. Folsom, mayor.  
Charles A. Stott, alderman.  
Cyrus H. Latham, alderman.  
William H. Anderson, councilman.  
Frederick T. Greenhalge, councilman.  
Albert A. Haggett, councilman.  
Edwin Lamson, councilman.

1871.

Edward F. Sherman, mayor.  
Albert A. Haggett, alderman.  
Henry P. Perkins, councilman.  
Jeremiah Crowley, councilman.  
William Dobbins, councilman.

1870.

Jonathan P. Folsom, mayor.  
Charles A. Stott, alderman.  
Albert A. Haggett, councilman.  
Wm. Kittredge, councilman.  
Wm. O. Fiske, councilman.

1872.

Josiah G. Peabody, mayor.  
Alexander G. Cumnock, alderman.  
Henry P. Perkins, councilman.  
Nathaniel C. Sanborn, councilman.  
Crawford Burnham, councilman.

## WATER COMMISSIONERS.

1870-'71-'72.

Levi Sprague, chairman.  
Wm. E. Livingston.  
Henry H. Wilder, resigned Sept. 26, 1871.  
Samuel K. Hutchinson, elected to fill vacancy.

## WATER BOARD.

1873.

Levi Sprague, president, from the citizens.  
William F. Salmon, from the citizens.  
Jonathan P. Folsom, alderman.  
Nathaniel C. Sanborn, councilman.  
Nathan W. Frye, councilman.

1878

Albert A. Haggett, president, from the citizens.  
James W. Bennett, from the citizens.  
Horace R. Barker, alderman.  
John F. Kimball, councilman.  
Charles H. Harvey, councilman.

1874.

Levi Sprague, president, from the citizens.  
William F. Salmon, from the citizens.  
Nathaniel C. Sanborn, alderman.  
Nathaniel W. Frye, councilman.  
G. W. S. Hurd, councilman.

1879.

Albert A. Haggett, president, from the citizens.  
James W. Bennett, from the citizens.  
Horace R. Barker, alderman.  
Edward B. Peirce, councilman.  
Robert G. Bartlett, councilman.

1875.

Geo. Runels, pres., from the citizens, resigned  
Nov. 9, 1875.  
Cyrus H. Latham, president *pro tem*, from the  
citizens.  
Benjamin Walker, alderman.  
Albert A. Haggett, councilman.  
Earl A. Thissell, councilman.

1880.

Albert A. Haggett, president, from the citizens.  
James W. Bennett, from the citizens.  
Robert Wood, alderman.  
Charles C. Hutchinson, councilman.  
Edward B. Peirce, councilman.

1876.

Cyrus H. Latham, pres., from the citizens.  
Earl A. Thissell, from the citizens.  
Albert A. Haggett, alderman.  
Benj. C. Dean, councilman, resigned May, 1876.  
John F. Kimball, councilman, elected to fill  
vacancy.  
Orford R. Blood, councilman.

1881.

Albert A. Haggett, pres., from the citizens.  
James W. Bennett, from the citizens.  
Robert Wood, alderman.  
Charles C. Hutchinson, councilman.  
Samuel Hosmer, councilman.

1877.

Cyrus H. Latham, president, from the citizens.  
Albert A. Haggett, from the citizens.  
Horace R. Barker, alderman.  
John F. Kimball, councilman.  
James W. Bennett, councilman.

1882.

Albert A. Haggett, president, from the citizens.  
Charles C. Hutchinson, from the citizens.  
Thomas R. Garity, alderman.  
William N. Osgood, councilman.  
Frank Wood, councilman.



## WATER BOARD.

1883.

Albert A. Haggett, pres., from the citizens.  
Charles C. Hutchinson, from the citizens.  
George W. Fifield, alderman.  
Edward B. Peirce, councilman.  
John J. Hogan, councilman.

1884.

Albert A. Haggett, pres., from the citizens.  
C. A. R. Dimon, from the citizens.  
George W. Fifield, alderman.  
Edward B. Peirce, councilman.  
John J. Hogan, councilman.

1885.

A. A. Haggett, pres., from the citizens.  
C. A. R. Dimon, from the citizens.  
James Francis, alderman.  
Alfred M. Chadwick, councilman.  
Arnold S. Welch, councilman.

*Investigations were made at various times, by order of the City Council,  
for the introduction of pure water into the city, viz: By Joint  
Special Committees consisting of the following-named citizens:*

1838.

Oliver M. Whipple, alderman.  
George Brownell, alderman.  
Thomas Hopkinson, councilman.  
Benjamin Walker, councilman.  
David Dana, councilman.

1839.

Oliver M. Whipple, alderman.  
John Clark, alderman.  
Thomas Hopkinson, councilman.  
Benjamin Walker, councilman.  
John Nesmith, councilman.

1848.

Jefferson Bancroft, mayor.  
Oliver M. Whipple, alderman.  
David Dana, alderman.  
John Avery, councilman.  
Otis L. Allen, councilman.  
Thomas Hopkinson, councilman.  
Ignatius Tyler, councilman.

1865.

George W. Norris, alderman.  
Edward F. Watson, alderman.  
Charles W. Dodge, councilman.  
T. L. P. Lamson, councilman.  
John Pearson, councilman.

1866.

Josiah G. Peabody, mayor.  
Charles W. Dodge, alderman.  
Joseph L. Sargent, alderman.  
Benjamin Walker, councilman.  
Edward C. Rice, councilman.

# WATER BOARD, 1885.

---

*President* . . . . . ALBERT A. HAGGETT.

Term expires first Monday in May, 1885.

C. A. R. DIMON,

Term expires first Monday in May, 1886.

Alderman, JAMES FRANCIS.

Councilman ALFRED M. CHADWICK.

Councilman ARNOLD S. WELCH.

*Clerk* . . . . . HORACE H. KNAPP.

*Superintendent of Works* . . . . . HORACE G. HOLDEN.

*Foreman of Works* . . . . . THOMAS DOYLE.

*Engineer at Pumping Station* . . . . . JAMES P. ROBERTS.

*Service Clerk* . . . . . LEONARD T. FARRIS.

*Meter Clerk* . . . . . WILLARD S. KNOWLTON.

## *Inspectors.*

JOHN J. BANCROFT.

ANDREW J. DEVOLL.

THOS. G. GERRISH, JR.

## *Inspectors of Meters.*

HENRY E. SPRAGUE,

THOMAS E. LENNON,

TIMOTHY H. BRENNAN.

§ 57. The Water office is open daily, from 9 A. M. to 3 P. M., and on Monday evenings, from 7 to 8 o'clock.

# REPORT OF THE WATER BOARD.

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OFFICE OF LOWELL WATER BOARD,

LOWELL, MASS., Jan. 12, 1885.

*To the City Council of the City of Lowell :*

GENTLEMEN—The Lowell Water Board in compliance with the Ordinances of the City of Lowell herewith present the Twelfth Annual Report of the Board :

The past year has been one of continued prosperity, and we are gratified to be able to report, notwithstanding the depression in business affairs and the consequent reduction in our sources of revenue, a substantial increase of the net charges for water during the year, of \$5000 in round numbers. The Works are in excellent condition, and in all departments have been well and carefully attended to by those in charge. For the details of work performed during the year we would refer to the Reports of the Superintendent and Engineer accompanying this Report, wherein may be found many interesting items in connection therewith. No new questions have arisen during the year regarding the administration of the Works, which would necessitate an allusion thereto in this Report, everything pertaining thereto having continued in a quiet and successful manner, and the work of the several departments having been performed with a faithful and conscientious regard to the city's interest.

The first meeting of the Board for the year 1884 was held on the evening of January 15th, the board being composed of the following members: Albert A. Haggett, President; and Charles C. Hutchinson from the citizens; Alderman Geo. W. Fifield, Councilmen John J. Hogan and Edward B. Peirce from the City Council.

#### ORGANIZATION.

The annual organization of the Board, under the provision of the City Ordinance occurred on May 5th, it being composed of the before mentioned persons, with the exception of Charles C. Hutchinson, succeeded by Col. C. A. R. Dimon who had been elected by the City Council for the two years ensuing.

Albert A. Haggett and Horace H. Knapp were respectively re-elected President and Clerk of the Board.

#### CONTRACTS.

February 2nd a contract was made with the Warren Foundry & Machine Co. of New York, the lowest bidder for 329 tons of cast iron-pipe and 25 tons of special castings for use on extensions of the works, at \$35.70 per ton of 2240 lbs. for the pipe, and 3 cents per lb. for special castings delivered on the cars in this city.

February 7th proposals were received and opened from dealers in this city for 1200 tons of Powelton mine coal to be delivered and stored in the coal house at the pumping station, and the contract was awarded to the lowest bidder, Whithed & Co., at \$4.94 per ton of 2240 lbs.

#### STATISTICS.

The total amount of water pumped into the reservoir for the year was 1,105,277,600 U. S. gallons, against

1,042,490,500 U. S. gallons in 1883, and the daily average pumped was 3,157,936 gallons, against 3,021,655 gallons in 1883, an increase for the year of 62,787,100 gallons and of 136,281 gallons in the daily average.

The quantity of coal consumed during the year for all purposes, excepting for the High Service supply, was 1,042 $\frac{1}{2}$  tons against 983 $\frac{1}{2}$  tons in 1883. For the High Service supply the consumption during the year was 302 $\frac{1}{2}$  tons against 27 $\frac{1}{2}$  tons in 1883.

There have been 529 $\frac{1}{2}$  gallons of water raised 165 $\frac{1}{2}$  feet high for each pound of coal consumed during the year.

The total number of water takers is 14,125 against 13,800 in 1883 a gain of 325 for the year. There are now laid 77 $\frac{1}{2}$  miles of street mains, the increase for the year having been 3 $\frac{1}{2}$  miles. The total net charges for water rates for the year after deducting all abatements, and the charges for service pipes, have been \$145,999.93 against \$141,316.82 for the year 1883, an increase for the year of \$4,683.11.

The following table will show the monthly charges for water, from the commencement of the Works to December 31, 1884, with all abatements, and total net charges:—

Charges for Water by Months, from Commencement to December 31, 1884.

MONTHS.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.
January . . . . .		\$ 363 04	\$ 418 96	\$ 150 45	\$ 126 51	\$ 169 13	\$ 282 44	\$ 233 73	\$ 182 58	\$ 233 37	\$ 271 52	\$ 472 76
February . . . . .		35 53	235 43	238 25	86 84	144 38	238 19	349 08	146 40	139 22	136 06	347 66
March . . . . .	\$ 6,124 94	50,200 10	65,417 68	82,249 51	89,177 52	82,295 43	80,003 60	80,567 44	80,210 88	90,856 37	94,956 65	98,692 13
April . . . . .	785 89	1,730 56	935 20	265 34	584 11	1,070 12	9,242 84	6,478 39	540 20	403 64	263 10	351 73
May . . . . .	3,988 16	3,274 09	2,147 96	874 47	1,819 65	1,121 43	2,751 35	1,476 15	879 61	1,191 41	984 84	1,495 90
June . . . . .	5,818 78	2,865 86	2,987 43	4,460 91	2,389 52	3,903 69	6,126 86	868 08	12,574 25	16,401 02	17,757 44	18,769 27
July . . . . .	4,833 52	1,880 03	1,926 31	582 68	3,147 78	1,261 24	1,213 13	11,457 84	873 00	959 80	1,059 37	899 21
August . . . . .	2,728 30	498 50	449 86	771 87	799 88	677 01	563 35	459 17	514 46	634 40	902 76	984 17
September . . . . .	2,827 07	3,245 06	805 90	495 97	3,493 90	4,998 07	6,584 86	8,108 23	10,088 19	10,994 30	12,467 32	12,939 94
October . . . . .	9,729 05	872 10	2,947 93	4,893 44	543 79	663 80	454 29	338 51	309 22	552 27	941 81	798 12
November . . . . .	761 21	634 03	573 35	1,445 65	518 72	1,220 27	1,405 89	629 56	973 16	378 97	1,615 65	693 41
December . . . . .	1,571 72	3,689 79	3,985 59	3,246 39	4,040 71	4,522 75	5,704 77	7,851 52	9,593 32	10,848 03	12,512 70	12,544 55
Totals . . . . .	\$39,168 64	\$69,397 39	\$82,861 60	\$99,674 93	\$98,178 93	\$102,877 32	\$115,281 26	\$118,808 70	\$125,975 27	\$133,503 45	\$143,809 22	\$148,928 85
Less ab'ments to date		1,872 83	640 06	8,185 88	2,502 65	4,343 13	9,590 05	1,702 13	3,766 88	2,490 50	3,004 15	2,928 82
Net amounts . . . .	\$39,168 64	\$67,494 56	\$82,221 54	\$91,489 05	\$95,676 28	\$98,534 19	\$105,671 15	\$117,106 57	\$122,208 39	\$131,012 95	\$140,775 07	\$145,999 93

## FINANCIAL STATEMENT.

The total gross amount of bills sent to the City Treasurer for collection for this department for the year ending December 31, 1884, is as follows:—

For Water Rates.....	\$92,515 12	
metered water.....	56,413 73	
	<hr/>	
Total for use of water.....		\$148,928 85
For service pipe and laying.....	\$1,791 52	
meters sold.....	2,640 50	
sundry accounts.....	5,986 60	
	<hr/>	
Total for pipe, meters, &c.....		\$10,418 62
Total charges for the year.....		\$159,347 47

The following statement exhibits the receipts and expenditures for the year, the net cost of the Water Works, including the interest on the Water Loan, and all expenses in excess of receipts for water rates; also the net cost and expenses of the Works by taxation:—

Net cost of the Water Works to January 1, 1884, as  
per last Annual Report.....\$2,350,179 21

Expended during the year for Water pipes and for laying  
the same and all other items of

## CONSTRUCTION.

## MATERIALS FOR MAINS, SERVICES, &amp;c.:—

Cast-iron pipe and special castings.....	\$13,902 52
Wrought-iron pipe and fittings.....	3,605 17
Brass connections.....	8 08
Lead and lead pipe.....	583 99
Teaming pipe.....	329 18
Pipe and service joints, hardware, powder, fuse, &c.....	471 08
Freight.....	990 54
Lumber.....	240 86

*Amounts carried forward,* \$20,131 42 \$2,350,179 21





TWELFTH

ANNUAL REPORT

OF THE

Lowell Water Board

TO THE

CITY COUNCIL

ACCOMPANIED BY THE REPORTS OF THE CITY ENGINEER AND OF  
THE SUPERINTENDENT OF WATER WORKS, TO THE  
WATER BOARD.

JANUARY 12, 1885.



LOWELL, MASS.  
HARRINGTON BROTHERS, PRINTERS, SUN OFFICE.  
1885.

42852

1903

## CITY OF LOWELL.

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IN COMMON COUNCIL, JAN. 13, 1885.

Read and sent to the Board of Alderman.

DAVID CHASE, *Clerk*.

---

IN BOARD OF ALDERMEN, JAN. 13, 1885.

Read and ordered placed on file.

SAMUEL M. CHASE, *City Clerk*.

# CIVIL ORGANIZATION, LOWELL WATER WORKS

From their commencement to Jan. 1, 1885.

## JOINT SPECIAL COMMITTEES.

1869.

Jonathan P. Folsom, mayor.  
Charles A. Stott, alderman.  
Cyrus H. Latham, alderman.  
William H. Anderson, councilman.  
Frederick T. Greenhalge, councilman.  
Albert A. Haggett, councilman.  
Edwin Lamson, councilman.

1871.

Edward F. Sherman, mayor.  
Albert A. Haggett, alderman.  
Henry P. Perkins, councilman.  
Jeremiah Crowley, councilman.  
William Dobbins, councilman.

1870.

Jonathan P. Folsom, mayor.  
Charles A. Stott, alderman.  
Albert A. Haggett, councilman.  
Wm. Kittredge, councilman.  
Wm. O. Fiske, councilman.

1872.

Josiah G. Peabody, mayor.  
Alexander G. Cumnock, alderman.  
Henry P. Perkins, councilman.  
Nathaniel C. Sanborn, councilman.  
Crawford Burnham, councilman.

## WATER COMMISSIONERS.

1870-'71-'72.

Levi Sprague, chairman.  
Wm. E. Livingston.  
Henry H. Wilder, resigned Sept. 26, 1871.  
Samuel K. Hutchinson, elected to fill vacancy.

## WATER BOARD.

1873.

Levi Sprague, president, from the citizens.  
William F. Salmon, from the citizens.  
Jonathan P. Folsom, alderman.  
Nathaniel C. Sanborn, councilman.  
Nathan W. Frye, councilman.

1878

Albert A. Haggett, president, from the citizens.  
James W. Bennett, from the citizens.  
Horace R. Barker, alderman.  
John F. Kimball, councilman.  
Charles H. Harvey, councilman.

1874.

Levi Sprague, president, from the citizens.  
William F. Salmon, from the citizens.  
Nathaniel C. Sanborn, alderman.  
Nathaniel W. Frye, councilman.  
G. W. S. Hurd, councilman.

1879.

Albert A. Haggett, president, from the citizens.  
James W. Bennett, from the citizens.  
Horace R. Barker, alderman.  
Edward B. Peirce, councilman.  
Robert G. Bartlett, councilman.

1875.

Geo. Runels, pres., from the citizens, resigned  
Nov. 9, 1875.  
Cyrus H. Latham, president *pro tem*, from the  
citizens.  
Benjamin Walker, alderman.  
Albert A. Haggett, councilman.  
Earl A. Thissell, councilman.

1880.

Albert A. Haggett, president, from the citizens.  
James W. Bennett, from the citizens.  
Robert Wood, alderman.  
Charles C. Hutchinson, councilman.  
Edward B. Peirce, councilman.

1876.

Cyrus H. Latham, pres., from the citizens.  
Earl A. Thissell, from the citizens.  
Albert A. Haggett, alderman.  
Benj. C. Dean, councilman, resigned May, 1876.  
John F. Kimball, councilman, elected to fill  
vacancy.  
Orford R. Blood, councilman.

1881.

Albert A. Haggett, pres., from the citizens.  
James W. Bennett, from the citizens.  
Robert Wood, alderman.  
Charles C. Hutchinson, councilman.  
Samuel Hosmer, councilman.

1877.

Cyrus H. Latham, president, from the citizens.  
Albert A. Haggett, from the citizens.  
Horace R. Barker, alderman.  
John F. Kimball, councilman.  
James W. Bennett, councilman.

1882.

Albert A. Haggett, president, from the citizens.  
Charles C. Hutchinson, from the citizens.  
Thomas R. Garity, alderman.  
William N. Osgood, councilman.  
Frank Wood, councilman.

## WATER BOARD.

1883.

Albert A. Haggett, pres., from the citizens.  
Charles C. Hutchinson, from the citizens.  
George W. Fifield, alderman.  
Edward B. Peirce, councilman.  
John J. Hogan, councilman.

1884.

Albert A. Haggett, pres., from the citizens.  
C. A. R. Dimon, from the citizens.  
George W. Fifield, alderman.  
Edward B. Peirce, councilman.  
John J. Hogan, councilman.

1885.

A. A. Haggett, pres., from the citizens.  
C. A. R. Dimon, from the citizens.  
James Francis, alderman.  
Alfred M. Chadwick, councilman.  
Arnold S. Welch, councilman.

*Investigations were made at various times, by order of the City Council,  
for the introduction of pure water into the city, viz: By Joint  
Special Committees consisting of the following-named citizens:*

1838.

Oliver M. Whipple, alderman.  
George Brownell, alderman.  
Thomas Hopkinson, councilman.  
Benjamin Walker, councilman.  
David Dana, councilman.

1839.

Oliver M. Whipple, alderman.  
John Clark, alderman.  
Thomas Hopkinson, councilman.  
Benjamin Walker, councilman.  
John Nesmith, councilman.

1848.

Jefferson Bancroft, mayor.  
Oliver M. Whipple, alderman.  
David Dana, alderman.  
John Avery, councilman.  
Otis L. Allen, councilman.  
Thomas Hopkinson, councilman.  
Ignatius Tyler, councilman.

1865.

George W. Norris, alderman.  
Edward F. Watson, alderman.  
Charles W. Dodge, councilman.  
T. L. P. Lamson, councilman.  
John Pearson, councilman.

1866.

Josiah G. Peabody, mayor.  
Charles W. Dodge, alderman.  
Joseph L. Sargent, alderman.  
Benjamin Walker, councilman.  
Edward C. Rice, councilman.

say 4 per cent. per annum, we should be able to show a surplus of over \$19,000 for the past year, in excess of all running expenses, and the annual interest on the Water Debt.

The time is near at hand however for so desirable a change, for in 1890 or five years from next November, we may confidently look to the "day of redemption," if not of all the bonds, most certainly from the high rate of interest thereon, and the refunding of the Debt upon such a lower rate of interest, as will most certainly render the Works self-sustaining besides providing annually for a large contribution to the Sinking Fund for the extinguishment of the Water Debt. For this very favorable outlook we are indebted to the careful and prudent management which has heretofore characterized the affairs of this important branch of our municipality, and we earnestly hope that the same conscientious discharge of affairs will obtain in the future.

In closing this report we desire to place upon record our testimony to the faithful and efficient service which has been rendered during the past year by the Superintendent of the Works, the Engineer at the Pumping Station, and the Clerk of the Board, and in fact to all employed in the Service of the Water Works. To the Inspectors, upon whose fidelity largely depends the revenue of the Works, we would give a cheerful commendation for honest and careful performance of their many, and oftentimes unappreciated duties. To one and all we extend our thanks for faithful performance of the work in their several spheres of action, and trust that the city may long have the benefit of their appreciated service. During the year Mr. Charles H. Harvey an Inspector of Meters, and a former member of the Board in the year 1878, resigned his position to enter into a more

lucrative position, and the vacancy was filled by the appointment of Mr. T. E. Lennon.

On Thursday and Friday, June 19th and 20th, of the past year the New England Water Works Association held its third annual meeting in this city, at the invitation of Superintendent Holden. The meeting was attended by a large number of the members of the Association, and was, we trust, productive of much that will pleasantly remind the members of the hospitality which is proverbial in our busy and industrious city. We desire to extend our thanks to the City Council of 1884 for the kindly assistance rendered to the Board in their efforts to make the visit of the Association a pleasant and agreeable one. That it was successful we have reason to know, by the repeated expressions of commendation given to the members of the committee in charge of the reception and entertainment of the Association, by the members thereof.

Respectfully submitted,

A. A. HAGGETT,  
CHAS. A. R. DIMON,  
JOHN J. HOGAN,  
GEO. W. FIFIELD,  
EDWARD B. PEIRCE,

*Members of the Lowell Water Board.*

IN WATER BOARD, JAN. 12, 1885.

Read and accepted, and ordered to be transmitted to the City Council.

Attest:

HORACE H. KNAPP,  
*Clerk.*



VAN B. SLEEPER, *City Treasurer and Collector of the City of Lowell,*  
in account with LOWELL WATER WORKS.

DR.		CR.	
1884.		1884.	
Jan. To bal from old ac.	\$ 1,946 47	By Payments during the year, viz:	
" " app'ion for 1884	16,000 00	Interest.	Salaries. Drafts. Refunds
" " Water Receipts,	7,831 86	Jan. \$ 1,230	\$158 33 \$ 2,715 43
Feb. "	4,065 02	Feb. 390	158 34 2,448 44
Mar. "	2,115 67	Mar. 210	150 05 2,432 62
Apr. "	5,521 97	Apr. 1,745	144 88 4,018 63
May "	34,204 42	May 46,000	144 88 11,888 15 \$692 43
June "	44,932 54	June 6,740	144 88 4,692 07 2 25
July "	17,473 61	July 720	144 88 10,990 70 2 50
Aug. "	11,671 39	Aug. 330	217 32 5,527 32
Sept. "	6,392 25	Sept. 120	144 88 6,638 33
Oct. "	9,176 19	Oct. 1,685	144 88 3,857 95 25 13
Nov. "	7,122 97	Nov. 44,740	144 88 3,002 75 2 50
Dec. "	4,576 37	Dec. 5,660	201 80 4,869 72 12 50
" Transfer to bal. acc't	2,168 69	Tot. \$100,570	\$1,900 00 \$63,082 71 \$737 31
	\$175,200 02		\$175,200 02

TWELFTH ANNUAL REPORT  
OF THE  
CITY ENGINEER TO THE WATER BOARD.

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JANUARY 1, 1885.



# REPORT OF THE ENGINEER.

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OFFICE OF CITY ENGINEER,

LOWELL, MASS., Jan. 1, 1884.

## *To the Lowell Water Board:*

GENTLEMEN:—The undersigned respectfully submits the Twelfth Annual Report of the work done by the pumping engines at the Pumping Station.

The calculations of the duty of the engines were made from the records kept by Mr. James P. Roberts, the engineer in charge.

All the coal used at the station has been charged to pumping, and no deduction of any kind has been made.

The average cost of pumping one million gallons from the low-service reservoir to the high-service reservoir is ten dollars, which, added to the cost of raising the same quantity into the low-service reservoir, makes the total cost of raising one million gallons into the high-service reservoir eighteen dollars and forty-seven cents.

During the year the Morris engine has run forty-five and the Worthington engine five nights. January 8th the Morris engine pumped 5,979,480 gallons, and June 25th the Worthington engine 5,785,110 gallons, which is the largest quantity pumped during any run of twenty-four hours.

Table showing Work done with Morris Engine (Beam and Fly-Wheel) and Boilers, for each Month during the Year 1884.

MONTHS.	No. of days Pumping.	No. of hours Pumping per day.	Number of hours pumping per month.	Number of strokes made per month.	Average No. of strokes made per minute.	Average head including friction in feet.	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. gallons.	No. gal. of water raised in reservoirs per oil per ton of coal consumed.	Duty in lbs. 1 foot high, with 100 lbs. coal, used in pump, only, no deduction for ashes or clinkers.	Duty on total coal consumed
January* . . . . .	28	15-16	427-40	320,429	12-49	166.76	102,537.250	3,663.046	569.	93,079,063	79,037,191
February . . . . .	26	12-08	31-35	236,948	12-51	167.03	75,823.360	2,916.823	553.	90,638,260	76,958,259
March . . . . .	29	11-20	328-45	248,336	12-59	165.24	79,467.520	2,740.259	551.	90,577,346	76,880,975
April . . . . .	19	11-06	211-00	180,739	12-70	163.32	51,436.480	2,707.183	556.	90,946,548	75,621,781
May . . . . .	21	11-04	232-30	175,407	12-57	163.33	56,130.240	2,672.869	547.	88,888,708	74,428,910
June* . . . . .	19	12-36	239-30	178,680	12-43	164.53	57,177.600	3,009.347	562	91,751,353	77,128,903
July* . . . . .	19	15-38	297-05	226,084	12-68	163.92	72,346.880	3,807.730	565.	92,023,953	77,213,838
August* . . . . .	26	15-44	409-00	303,247	12-36	164.92	97,039.040	3,732.271	559.	92,173,230	76,872,996
September* . . . . .	24	13-58	335-15	252,896	12-57	164.61	80,926.790	3,371.946	553.	90,554,731	75,885,243
October* . . . . .	27	14-08	381-40	288,781	12-61	164.47	92,409.920	3,422.589	553.	90,153,483	75,802,392
November* . . . . .	22	13-14	291-15	220,809	12-64	164.17	70,658.880	3,211.767	559.	91,091,076	76,525,747
December* . . . . .	25	15-57	398-50	299,617	12-52	163.68	95,877.440	3,835.097	554.	90,460,151	76,608,320
Totals and averages	285	13-34	3868-05	2,911,973	12-55	164.65	931,831.360	3,269.584	557.	91,034,207	76,443,876

\* Engine run some nights in this month.

Table showing work done with Worthington Duplex Engine for each month during the year 1894.

MONTHS.	No. of days pump-ing.	Ave. No. of hours pumping per day.	No. of hours pumping per month.	No. of strokes made per month.	Average No. of strokes made per minute.	Average head, including friction in feet	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. gallons.	No. gal. of water foot-high, with 100 lbs. coal, to reserve, used in pumping only, no deduction for total coal consumed.	Duty in lbs. of coal consumed	Duty on total coal consumed no deduction for ashes or clinkers.
January . . . . .	3	14-42	44-05	34,241	12.95	163.49	10,614,710	3,538,237	440.	69,532,768	60,011,686
February . . . . .	5	11-06	55-30	35,423	10.64	167.34	10,981,130	2,196,226	418.	68,674,490	58,229,711
March . . . . .	8	10-58	87-45	44,437	8.44	170.64	13,775,470	1,721,934	381.	61,546,606	54,221,651
April . . . . .	9	11-19	101-50	81,413	13.32	166.29	25,238,030	2,804,226	407.	66,059,787	56,349,924
May . . . . .	10	10-35	105-50	80,562	12.69	165.69	24,974,220	2,497,422	437.	72,893,505	60,385,059
June* . . . . .	11	14-04	154-40	106,540	11.48	167.32	33,027,400	3,002,491	417.	69,970,964	58,208,916
July* . . . . .	9	14-21	129-10	96,826	12.49	165.60	30,016,060	3,335,118	426.	71,565,470	58,874,982
August . . . . .											
September . . . . .	4	9-34	38-15	28,971	12.62	166.19	8,981,010	2,245,252	428.	69,105,182	59,233,020
October . . . . .											
November . . . . .	2	12-03	24-10	16,596	11.44	165.30	5,144,450	2,572,225	422.	66,895,315	58,122,169
December . . . . .	4	12-38	50-30	34,496	11.38	164.04	10,693,760	2,672,440	435.	68,315,612	59,429,035
Totals and Averages . . . . .	65	12-11	791-45	559,504	11.78	166.21	173,446,240	2,668,404	420.	68,054,070	58,169,307

\* Engine run two nights.

Table Showing Amount of Coal Used for Morris Engine at Pumping Station During the Year 1884.

MONTHS.	COAL CONSUMED.			
	For starting fires in Pounds.	When pumping, in Pounds.	For banking fires in Pounds.	Total per Month in Pounds.
January, . .	20,400	153,100	6,800	180,300
February, . .	15,300	116,450	5,400	137,150
March, . . .	17,400	120,820	6,000	144,220
April, . . .	11,400	76,980	4,200	92,580
May, . . . .	12,300	85,960	4,400	102,660
June, . . . .	12,000	85,450	4,200	101,650
July, . . . .	15,000	107,400	5,600	128,000
August, . . .	21,000	144,700	7,800	173,500
September, . .	17,100	122,600	6,600	146,300
October, . . .	19,200	140,500	7,400	167,100
November, . .	14,400	106,130	5,800	126,330
December, . .	21,000	144,580	7,400	172,980
Totals, . . .	196,500	1,404,670	71,600	1,672,770

Table Showing Amount of Coal Used for Worthington Duplex Engine at Pumping Station During the Year 1884.

MONTHS.	COAL CONSUMED.			
	For starting fires in Pounds.	When pumping, in Pounds.	For banking fires in Pounds.	Total per Month in Pounds.
January, . . .	2,400	20,800	900	24,100
February, . . .	3,000	22,300	1,000	26,300
March, . . . .	2,700	31,830	1,600	36,130
April, . . . .	7,800	52,470	1,800	62,070
May, . . . . .	7,800	47,310	2,000	57,110
June, . . . . .	10,500	65,820	2,800	79,120
July, . . . . .	9,900	57,900	2,600	70,400
August, . . . .				
September, . .	2,400	18,000	600	21,000
October, . . . .				
November, . . .	1,200	10,600	400	12,200
December, . . .	2,400	21,400	800	24,600
Totals, . . . .	50,100	348,430	14,500	413,030

Table Showing Work Done with Worthington High-Service Engine, 1884.

MONTHS.	No. of days pumping.	Average number of hours pumping per day.	Number of hours pumping per month.	Number of strokes made per month.	Average number of strokes made per minute.	Average head, including friction in feet.	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. gallons.	No. of Gallons pumped into reservoir per lb. of total coal consumed.	Coal in lbs. used when pumping.
January, . . .	5	9-12	46-00	96,759	36.14	76.82	1,396,626	279,325	319	4,380
February, . . .	4	9-20	37-20	77,785	34.73	76.35	1,089,130	272,282	320	3,400
March, . . .	5	10-32	52-40	118,386	37.46	77.74	1,657,404	331,481	326	5,080
April, . . .	4	9-14	36-55	84,237	38.03	77.51	1,179,318	294,829	323	3,650
May, . . .	5	10-07	50-35	107,248	35.34	77.51	1,501,472	300,294	319	4,700
June, . . .	5	11-21	56-45	125,726	36.92	78.20	1,760,164	352,683	320	5,500
July, . . .	7	12-26	87-00	174,991	33.52	77.90	2,449,874	349,982	310	7,900
August, . . .	7	9-57	69-40	149,815	35.84	79.66	2,097,410	299,630	328	6,390
September, . . .	5	9-39	48-15	100,267	34.63	78.43	1,403,738	280,748	297	4,730
October, . . .	6	11-50	71-00	156,687	36.78	78.85	2,193,618	365,903	325	6,750
November, . . .	3	8-53	26-40	59,030	36.89	68.27	826,420	275,473	321	2,570
December, . . .	6	9-43	58-20	115,584	33.02	78.09	1,618,176	269,696	325	4,980
Totals and averages,	62	10-20	641-10	1,399,525	35.60	77.95	19,173,350	309,248	319	60,030



## PUMPING STATION, MORRIS ENGINE.

Running Expenses for the Year 1884.

Pay of engineer and firemen.....	\$2,815 45
396 $\frac{160}{2000}$ tons coal (Powelton) 1883, at \$4.99.....	1,976 44
440 $\frac{610}{2000}$ tons coal (Powelton) 1884, at \$4.44.....	1,956 72
2 $\frac{3}{4}$ cords wood, at \$4.00.....	9 50
Gas for lighting works.....	32 51
35 lbs. tallow.....	3 70
85 gallons cylinder oil, at 65c.....	55 25
82 gallons crude and parafine.....	18 14
103 lbs. cotton waste, at 12 $\frac{1}{2}$ c.....	12 88
30 $\frac{1}{2}$ lbs. soapstone packing, at 30c.....	9 15
15 lbs. hemp packing.....	4 97
14 $\frac{1}{8}$ lbs. asbestos packing, at 20c.....	2 83
Repairs on engine and pump.....	89 89
Repairs on boilers.....	316 14
Sundries.....	44 06
Total.....	<u>\$7,347 63</u>

Cost of raising water into reservoir, per million gallons..... \$7 88

Cost of raising water one foot high, per million gallons..... 04  $\frac{39}{100}$ 

## WORTHINGTON ENGINE.

Running Expenses for the Year 1884.

Pay of engineer and firemen.....	\$524 35
151 $\frac{230}{2000}$ tons coal (Powelton) 1883, at \$4.99.....	756 56
54 $\frac{180}{2000}$ tons coal (Powelton) 1884, at \$4.44.....	243 98
Wood.....	3 00
Gas for lighting works.....	10 84
26 gallons cylinder oil, at 65c.....	16 90
24 lbs. cotton waste, at 12 $\frac{1}{2}$ c.....	3 00
10 lbs. soapstone packing, at 30c.....	3 00
13 lbs. asbestos packing and rubber.....	3 73
Repairs on engine.....	380 74
Repairs on boilers.....	58 87
Sundries.....	10 00
Total.....	<u>\$2,014 97</u>

Cost of raising water into reservoir, per million gallons... \$11 62

Cost of raising water one foot high, per million gallons... .06  $\frac{79}{100}$

## RESERVOIR, 1884.

The following table shows the average depth of water, the number of gallons and the temperature of the water in the reservoir, and also the temperature of the air for each month. The temperature of the water was taken at 6 A. M. and 6 P. M., and of the air at 6 A. M., 1 and 6 P. M.

MONTHS.	Depth in Feet.	Quantity in U. S. Gallons.	Temperature in Degrees.	
			Of Water.	Of Air.
January .....	19.52	29,767,300	33.0	19.9
February.....	19.56	29,834,400	33.6	29.6
March.....	19.74	30,138,900	35.2	33.0
April.....	19.51	29,754,700	42.0	44.6
May.....	19.71	30,084,200	55.1	58.6
June.....	18.94	28,790,400	66.5	72.7
July.....	18.75	28,484,800	71.5	72.8
August.....	19.08	29,029,800	71.9	72.2
September .....	18.57	28,175,700	67.8	67.8
October.....	18.89	28,718,100	56.3	52.3
November.....	19.15	29,151,000	39.6	39.9
December.....	18.66	28,337,700	33.2	30.3

The following table shows the average monthly and daily consumption of water for the year 1884 :

MONTHS.	Gallons per Month.	Gallons per Day.
January .....	111,604,800	3,600,150
February.....	87,931,410	3,032,120
March.....	93,803,070	3,025,910
April.....	75,411,170	2,513,700
May.....	81,245,390	2,620,820
June.....	93,819,970	3,127,330
July.....	98,747,970	3,185,420
August .....	98,161,450	3,166,500
September.....	93,357,400	3,111,910
October .....	86,990,100	2,806,130
November .....	79,440,220	2,648,010
December.....	103,358,820	3,334,160
Total and average.....	1,103,871,770	3,016,040

Respectfully submitted,

GEO. E. EVANS, *City Engineer.*

TWELFTH ANNUAL REPORT  
OF THE  
SUPERINTENDENT OF WATER WORKS,  
TO THE  
LOWELL WATER BOARD.

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JANUARY 1, 1885.



# REPORT OF THE SUPERINTENDENT.

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SUPERINTENDENT'S OFFICE, CITY HALL,

LOWELL, January 1, 1885.

*To the Lowell Water Board :*

GENTLEMEN—In accordance with the requirements of the City ordinance, I respectfully submit herewith the twelfth annual report of the Superintendent of the Lowell Water Works for the year ending December 31st, 1884.

The total amount of water pumped into the reservoir during the year was 1,105,277,600 gallons, an increase of 62,787,100 gallons over the amount pumped in 1883. Giving an average daily consumption of about 43 gallons of water per each inhabitant. This includes all the water that is used for manufacturing purposes as well as for domestic use, also for street drinking fountains, extinguishing fires, sprinkling streets, etc. The total quantity of water sold by meter measurement amounts to 281,946,400 gallons, an increase over last year of 21,721,400 gallons. The works and everything connected with them are in good condition, and taking into consideration that over 12 years have elapsed since the pumps were first started, the repairs so far have not been unusually large.

The filter gallery has been drawn down twice this year, June 6th and October 18th. Also at the same times, the conduit was blown off at the Beaver Brook standpipe, and the pump wells thoroughly cleaned. August 19th and 20th all the mains throughout the city were given a thorough blowing out, and since then no complaints in regard to the quality of the water have been made.

#### PUMPING STATION.

At the pumping station the Morris engine has pumped 931,831,360 gallons, and the Worthington has pumped 173,446,240 gallons of water. On the Morris engine the valve seats to the low pressure cylinder had corroded so much that two of the seats had to be rebored and two new valves fitted to them. At the same time the six valve stems were replaced by new ones.

An examination of the Worthington engine Nov. 8th found both of the low pressure pistons cracked, probably owing to castings being too light and not properly strengthened. The pistons were immediately shipped to H. R. Worthington, New York, with the request that stronger castings be used with thicker ribs, and returned as soon as possible. The new pistons which were returned are each 275 pounds heavier than the old ones, and are so well strengthened now that no more trouble need ever be feared from them.

Seven new stays have been put into each of the three old boilers, which have been in use ever since the works were first started, and the middle boiler has had a set of new wrought iron tubes throughout, in place of the composition tubes, which were badly corroded, especially at the ends.

A 6-ton Fairbanks platform scales has been set at the entrance to the coal shed, and all the coal now purchased is weighed on its delivery to the works.

The cornices, doors, window frames and all the iron fence has been repainted. Also all the machinery has been repainted and varnished.

New ventilators have been placed upon the roof of the boiler house and engine room, the old copper roofing removed and the roof now covered with 6-ply mopped roofing and graveled.

#### HIGH SERVICE.

During the year 19,173,350 gallons of water were pumped into the high service reservoir, an increase of 435,568 gallons over last year. Six-inch mains have been extended in Belmont avenue, Mansur and Talbot streets. Three new services in Belvidere and 5 in Centralville have been added, making a total of 114 houses, 6 stables, 2 fountains and 30 fire hydrants now supplied with water from the high service system.

**EXTENSIONS.**

17,731 1-2 feet of cast iron pipe for mains have been laid this year, an increase of 576 1-2 feet more than were laid last year. This is the largest amount, with the exception of the year 1881, when the high service works were constructed, that has been laid in any year since 1876, and is owing to the large number of streets which have been lately laid out on the Hildreth estate and the Rogers farm.

The 24-inch reserve line across the Merrimack river at Hunt's Falls has been extended, and connections made on both sides of the river with the 12-inch high service line, so that in case of accident to the 12-inch line, the water can be turned on to the reserve line without delay.

A 20-inch blow-off has also been connected to the reserve line on the Centralville side of the river.

**LEAKS.**

There has been 1 leak in joint of main pipe on Mammoth street, 1 main pipe cracked on Walker street, 1 hydrant blew off on French street, and 1 leak in the cement lined pipe on Middlesex street.

Thirteen service pipes have broken off, principally occasioned by the settling of sewer trenches.

**HYDRANTS.**

There have been 17 post hydrants set on extensions. The flush hydrant on Taylor street, corner of Merrill street, has been removed, and a post hydrant set on the opposite corner. New valves and other repairs have been made on 15 flush hydrants and 12 post hydrants. The hydrant on Meadowcroft street has been taken up and reset on Bolt street.

A 4-inch fire service has been put into Wm. Walker & Son's mill on Lawrence street, a 4-inch pipe has been laid into the premises of Woods, Sherwood & Co., on Bridge street, and a 4-inch fire service laid into Huntington Hall on Shattuck street.

**METERS.**

There are now 1,348 meters in use, an increase of 102 over last year.



The following amount of work has been done on meters: Meters set during the year, 114; meters taken out and others set for various causes, 113; Desper meters taken out, repaired and reset, 50; Desper meters frozen and destroyed, 9; Desper meters requiring new spindle packing, 298; Worthington meters taken out, repaired and reset, 59; Worthington meters frozen and destroyed, 1; Worthington meters worn out and replaced by others, 4; Ball & Fitts meters worn out and replaced by others, 24.

TABLE OF METERS IN USE DEC. 31, 1884.

KINDS.	$\frac{3}{8}$ in.	$\frac{1}{2}$ in.	1 in.	$1\frac{1}{2}$ in.	2 in.	3 in.	4 in.	Motor Register.	Totals.
Desper, . . . . .	486	139	64	1	. . . . .	. . . . .	. . . . .	. . . . .	690
Worthington, . . . . .	311	29	49	66	23	5	2	. . . . .	485
Crown, . . . . .	37	28	12	. . . . .	2	. . . . .	1	. . . . .	80
Duplex, . . . . .	17	14	9	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	40
Ball & Fitts, . . . . .	21	9	2	1	. . . . .	. . . . .	. . . . .	. . . . .	33
Fitts Rotary, . . . . .	12	1	1	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	14
Equitable, . . . . .	2	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	2
Motor Register, . . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	4	4
Total, . . . . .	886	220	137	68	25	5	3	4	1348

## SERVICES.

During the year the water has been shut off from the premises of 39 water takers for non-payment of water rates, and the number let on upon payment of the rates is 33. The whole number of services remaining shut off for non-payment is 6. Three hundred new services have been put in this year, making a total of 6,953 services now laid. Of these 270 have been discontinued, and are shut off and disconnected from the Main pipe.

The amount of service pipe laid is as follows :

Laid during 1884,	$\frac{3}{4}$ inch.....	2,449 feet
" " "	1 inch.....	7,276 "
" " "	$1\frac{1}{4}$ inch.....	86 "
" " "	$1\frac{1}{2}$ inch.....	863 "
" " "	2 inch.....	443 "
Total laid during 1884.....		11,117 feet
Add amount previously laid.....		247,203 "
Total amount laid.....		258,320 feet

#### ITEMS OF OTHER WORK DONE.

During the past year every service box, street gate and hydrant has been inspected and put in good order. Large pipe drinking fountains have been set in place of old ones on Cabot street near Merrimack street, Middlesex street near Gorham street, Broadway near School street, Fletcher street, corner of Willie street, and Merrimack street near Bridge street. A new drinking fountain has been set on Gorham street opposite Moore street, and a self-closing fountain on Fletcher street near Dutton street. The gate houses at the filter gallery and reservoir have been repainted and whitewashed, and the reservoir grounds kept in good order. Thirty-one stop gates have been repaired and the stuffing boxes packed.

In addition to the main pipes there has been laid an amount of smaller sizes, as follows :

## SCHEDULE OF SMALL PIPE LAID.

STREETS.	1 INCH.	1 1-2 IN.	TOTAL
Adams Court . . . . .		234	
Anderson . . . . .		190	
Canada . . . . .	116		
Lawrence . . . . .		190	
Manufacture . . . . .		164	
Nichols . . . . .		237	
Quimby Ave. . . . .	40		
Riverside Ave. . . . .	144		
Sargent . . . . .		63	
West Court . . . . .		109	
West Manchester . . . . .	164		
Washington . . . . .	21		
Wright . . . . .	156		
Total . . . . .	641	1187	1228

## NUMBER AND KIND OF SERVICES CHANGED DURING THE YEAR.

SIZE OF SERVICES CHANGED FOR		1 inch.	1 1-4 inch	1 1-2 inch	2 inch.	Total.
49 . . . . .	3-4 inch.	2,157				2,157
6 . . . . .	3-4 inch.		159			159
21 . . . . .	3-4 inch.			1,194		1,194
2 . . . . .	3-4 inch.				80	80
78 Totals . . . . .		2,157	159	1,194	80	3,590

In conclusion, I desire to express my sincere thanks to your honorable Board for the uniform kindness extended to me in the discharge of my several duties during the past year.

Respectfully submitted,

HORACE G. HOLDEN, *Sup't.*

## LOW SERVICE.—WATER PIPES LAID IN 1884.

STREETS.	BETWEEN WHAT STREETS	LENGTH IN FEET.					
		20 in.	12 in.	8 in.	6 in.	4 in.	Total.
A . . .	Extended westerly .				121		121
Aiken ave. .	East of Hildreth .				239		239
Beacon . .	Connected with 19th .				771		771
Bolt . . .	So. easterly from Meadowcroft . . .				517½		517½
Bowers . .	Westerly f'm Mt. Vernon				157½		157½
Butler . .	No. f'm Woodward ave.				344		344
Concord . .	Extended southerly .				857½		857½
Court . . .	Westerly from Butler .					212½	212½
Cumberland r'd.	No. and So. f'm Lilley av.				390		390
Fletcher Lane .	Northerly f'm Shaw .					250	250
Frye . . .	So. from New Fletcher				326½		326½
Fulton . . .	Extended southerly from W. Sixth . . .				357		357
Harrison . .	Extended southerly .				686		686
Hastings . .	Southerly from Liberty				813		813
High . . .	Extended southerly .				379½		379½
Lawrence . .	Southerly f'm Faulkner			283			283
Lawrence . .	F'm gateway Lowell Cemetery So. easterly .					414	414
Lilley avenue .	Hildreth and Dutton				1,036		1,036
Ludlam . .	Northerly from Cumberland road . . .				206		206
Maple . . .	Westerly from Gorham				123½		123½
Old Meadow r'd.	Extended So. westerly				335		335
Osgood . .	Southerly from Westford					215	215
Pine . . .	Westerly from Wilder .				374		374
Plain . . .	So. east of Chelmsford extended . . .				48		48
Pleasant . .	Extended southerly .				271		271

## LOW SERVICE.—WATER PIPES LAID IN 1884.—Concluded.

STREETS.	BETWEEN WHAT STREETS.	LENGTH OF FEET.					
		20 in.	12 in.	8 in.	6 in.	4 in.	Total.
Quimby Av.	Extended southeasterly					78	78
River .	" n.w'ly to Dracut line			2,150	347		2,497
River connection	At Merrimack River .	185	60				245
Royal . .	Extended southerly .				238½		238½
Rogers .	Harrison and Clay .				230		230
Stevens . .	South of Pine, extended			72			72
Shaw . .	Extended to Chelmsford				232½		232½
Tanner . .	Southw'ly from Howard				688		688
Tanner . .	Southw'ly from Lincoln					704	704
Taylor .	Extended easterly .			13			13
Washington .	Sautherly from Leverett					413½	413½
Ware . .	Extended southerly .				66½		66½
West . .	Extended northerly .				412		412
West Mason	Westerly from Hastings				57½		57½
Woodward Av.	M'moth Road and Butler				870½		870½
Street . .	South'ly from Aiken Av.				308		308
	Hydrants . . . .				136		136
Total in feet . . . . .		185	60	2,518	11,939½	2,287	16,989½
Length short'ed by relay'g Meadowcroft st					37		37
		185	60	2,518	11,902½	2,287	16,962½
Meadowcroft relaid 400 feet on account of change in st. lines, length now is .					1,572		1572
Length previously given, 1600—37 ft dif.							
Taylor relaid with 8-inch pipe . . .				235			235

## HIGH SERVICE—WATER PIPES LAID IN 1884.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.					
		24 in.	30 in.	18 in.	6 in.	4 in.	
Belmont ave. .	Mansur and Talbot, .				286		286
Mansur, .	Extended to Belmont av.				185		185
Talbot, . .	Extended to Belmont av.				297		297
	Hydrants, . . .				11		11
	Totals, . . .				779		779

HIGH AND LOW SERVICE—SUMMARY OF WATER PIPES  
LAID IN 1884.

	24 inch.	20 inch.	8 1-2 in.	6 inch.	4 inch.	Totals.
Low Service, . . . .	185	60	2,518	1190 1/2	2,287	16,952 1/2
High Service, . . . .				779		779
Total in feet, . . . .	185	60	2,518	1208 1/2	2,287	17,731 1/2
Pipes laid previous to 1884 .						389,847
Total in feet, Jan. 1, 1885						407,578 1/2
Total in inches, Jan. 1, 1885						77.10

LIST OF HYDRANTS SET DURING THE YEAR ENDING  
DEC. 31, 1884.

STREETS.	LOCATIONS.
Beacon,	Westerly side, 148 feet southerly from 19th street.
*Bolt,	Northerly side, 269 feet easterly from Meadowcroft Street.
Butler,	Westerly side, 12 feet south from Court Street.
Concord,	Westerly side, 5 feet southerly from Rogers Street.
Frye,	Westerly side, 2 feet southerly from new Fletcher street.
Harrison,	Westerly side, 3 feet northerly from northerly line Porter St.
Hastings,	Easterly side, 725 feet southerly from south line Liberty St.
Lawrence,	Easterly side at southerly end of Lowell Cemetery.
Lilley Avenue,	Northerly side, six feet east from Cumberland Road.
Lilley Avenue,	Northerly side, 39 feet east from Dalton Street.
River,	Northerly side, 4 feet east from Dracut Line.
River,	Northerly side, 878 feet easterly from Dracut Line
Royal,	Easterly side, 371 feet southerly from Westford Street.
Rogers,	Northerly side 4 feet west from westerly line Harrison St.
Shaw,	Northerly side, 35 feet west from Chelmsford Street.
Tanner,	Easterly side opposite office of Richard Dobbin Boiler Works.
Washington,	Westerly side, 465 feet southerly from Leverett St.
*Taylor,	Northerly side, 4 1-2 feet east from east line Merrill Street.

All post hydrants,

\*Moved from Meadowcroft Street.

\*Flush hydrant on Northwest corner was taken out.

HIGH SERVICE.

Talbot, Northerly side, 97½ west from West line Belmont Avenue.

**LIST OF STOP GATES SET DURING THE YEAR ENDING  
DEC. 31, 1885.**

STREET.	LOCATION.	24 inch.	12 inch.	8 inch.	6 inch.	4 inch.
Hastings	12.2 feet west from east line Hastings street; 1.0 foot south from south line Liberty.				1	
Lilley Avenue	4.0 feet west from west line Hildreth, 15.0 feet south from north line Lilley Avenue.			1		
Maple	17.6 feet north from south line Maple Street; 1.0 foot west from west line Gorham Street.			1		
Osgood	3.7 ft. south from southerly line Westford; 13.6 feet east from West line Osgood Street.					1
River Crossing	North side of river; 20 inch—1	1	1			
	South side of river.	1	1			
Shaw	2.0 feet west from westerly line Chelmsford; 13.4 feet south from north line Shaw.			1		
Tanner	19 ft. east from west line Tanner St. about on westerly line Howard street.					1
Tanner	1.5 feet southerly from south westerly line Lincoln; 15 feet northwesterly from bound southwesterly corner Lincoln and Tanner.					1
*Taylor	23 feet southerly from northerly line Taylor St. on east line Lawrence street.			1		
Woodward Av.	4 feet westerly from westerly line Mam. Road; 7 feet northerly from southerly line Woodward Avenue.					1

\*Replaces 4-inch gate.



LIST OF STOP GATES FOR FIRE SERVICES SET DURING  
THE YEAR ENDING DEC. 31, 1884.

STREETS.	LOCATION.				6 inch.	4 inch.
Walker's Mills	17. 5 feet north from south line Middle Street; 5 feet west from east line Lawrence Street.					1
Woods, Sher- wood & Co.	27 feet north from north line Seventh Street; 2 feet inside Woods & Sherwood's yard.					1
Huntington Hall	40 feet southwest from S. W. line Middle Street; 2. 6 ft. S. east from N. west line Shattuck St.					1

## HIGH SERVICE.

STREETS.	LOCATION.				6 inch.	4 inch.
Mansur	18.0 feet north from south line Mansur Street, and on west line Belmont Avenue.					1
Talbot	14.8 feet south from north line Talbot Street; 1.0 foot west from west line Belmont Ave.					1

## PROPERTY AT PIPE YARD JANUARY 1, 1885.

DIAMETER IN INCHES.	4	6	8	10	12	16	20	24	30
Lengths . . . . .	70	50	30	25	121	5	18	12	6
Sleeves . . . . .	5	28	2	4	20	11	5	10	9
Caps . . . . .	6	28	30		18	3	1	3	
Curves . . . . .	16	13	10	2	10	4	10	3	2

DIAMETER IN INCHES.	4x4	6x4	6x6	8x6	8x8	10x8	10x6	12x6	12x8	12x10	12x12	10x6	16x8	16x12	16x16
3-Ways . . . . .	6	8	8				1	15	7				1		
4-Ways . . . . .			11	7	1		1				1	1		3	
Reducers . . . . .				5		1	6	3	3					1	

**Wrought Iron Pipe.**—100 feet 2-inch, 700 feet 1 1/2-in., 50 ft. 1-inch, 500 feet 3/4-inch. **Stop Gates.**—1 4-inch, 1 6-inch, 1 8-inch, 1 8-inch old style. **Hydrants.**—1 post, 1 flush, 18 second-hand hydrants, 7-hydrant frames and covers, 2 gate frames and covers. **Solder Nipples.** 34 1-inch, 2 2-inch 48 3/4-inch. **Tees.**—10 3/4 inch, 35 1-inch. **Crosses.**—30 3/4-inch. **Unions.** 30 5/8 inch, 40 3/4-inch, 30 5/8-solder unions, 60 right 5/8-in. solder unions, 85 1-inch. **Bushings.**—25 assorted bushings, elbows 100 assorted. **Sockets.** 13 3/4-inch sockets, 45 1-inch **Corporation Cocks.**—14 5/8-inch, 45 1-inch. **Stop and Waste Cocks.**—18 3/4-inch, 7 1-inch, 4 5/8-inch, 1000 assorted couplings. **Lead Connections.**—80 1-inch, 8 1/2-inch, 6 iron sidewalk boxes, 100 wood sidewalk boxes. 1 hydrant box, 2 saw horses, 2 buck saws, 8 hand-saws, 1 pipe testing machine, 2 pipe benches, 4 tool boxes, 3 derricks, 1 fall rope and blocks, 2 set iron patent pully blocks, 1 chain, 4 wheelbarrows, 2 tongs for cleaning sidewalk boxes. 2 old style gate covers, 4 set castings for drinking fountains, 1 cord logs for blasting purposes, 1 1/2 tons hay, 1 1/2 tons carrots, 4 horse blankets, 2 canvass horse covers, 2 horses, 4 set harnesses, 100 feet drain pipe, 50 pick handles, 7 crowbars, 60 feet rubber hose, 1 hose reel, 2 brass goose necks for hydrants, 30 calking sets, 5 nail hammers, 300 sidewalk caps, 4 pairs rubber boots, 150 feet canvass hose, 30 iron lug straps, 250 lbs. bolts, 10 assorted files, 12 assorted gravel screens, 5 hanging irons for bridges, 10 iron bands for pipe, 75 lbs. cotton waste, 200 lbs. iron, 1 grind stone, 1 set blacksmith tools, 6 screw-drivers, 10 lbs. iron washers, 30 lbs. assorted nuts, 5 hand hatchets, 1 axe, 3 trowels, 800 lbs. steel in drills, 4 scrapers for blasting purposes, 8 lbs. pipe wedges, 3 yarning irons, 2 lead ladles, 5 sling ropes, 1 iron rake, 6 square pointed shovels, 8 wood plugs for main pipe, 5 lbs. shims and wedges, 2 tag ropes, 1 root axe, 1 dualin pot, 1 ten gallon can, 200 lbs. old brass, 2 surcingles, 2 halters, 2 pungs, 2 horse brushes, 2 hay forks, 2 manure forks, 1 wagon jack, 2 express wagons, 12 hammer handles, 1-16 foot straight edge, 10 striking hammers, 9 steel points, 400 lbs. pig lead, 3 set old blocks, 2 lead pots, 2 furnaces for melting lead, 1 zinc pump, 1 Edison patent pump, 2 copper force pumps, 1 keg 10d nails, 1-4 keg 20d nails, 2 wagon wrenches, 40 assorted wrenches, 8 rammers, 3 paving mauls, 40 shovels, 50 picks, 8 draught chains, 1 bbl. cement, 1-4 bbl. white clay, 2 snow shovels, 1 work shop, 1 carriage house, 1 stable, 1 store shed, 2 spirit levels, 1 rubber diaphragm for pumps, 200 feet lumber for repairing boxes, 1 pattern for making boxes, 17 dippers for drinking fountains, 75 feet 3/4-inch lead pipe, 150 feet block tin wire, 2 portable closets, 12 lanterns, 1-2 gross lump wicks, 2 ratchet cutters, 4 pipe cutters, 4 pipe vices, 15 dies, 2 ratchet die plates, 3 die plates, 4 pipe tongs, 1-2-inch auger, 2 1-2-inch taps, 2 1-inch taps, 1 1 1/2-inch taps, 5 oil cans, 5 bottoms for Worthington meter, 2 lbs. sealing wax, 1 box crayons, 1-4 box wax candles, 19 assorted gate screws, 3 set packing patterns, 5 lbs. leather, 1 wire brush, 2 oil pans, 1 brass lantern, 2 brass lamps, 125 feet block tin tubing, 1 solder pot and mould, 2 pairs pliers, 1 pair cut nippers, 2 hard packings for meters, 10 valve and valve seals, 1 roll packing paper, 30 spindles to Worthington meter, 3 taping machines, 1 leather tool bag, 1 tin match safe, 2 rubber connections, 1 fore plane, 1 iron wood mallet, 3 solder irons, 1 press drill, 2 washer cutters, 1 set steel numbers, 1 lath dog, 1 foot lathe, 1 universal chuck, 1 seive, 1 iron bucket for testing meters, 3 bits, 10 ends to Worthington meter, 1 surface plate, 1 5-gal. can, 1 2-gal., 2 1-gal., 2 1-2-gal., 1 quart, 1 4-quart wood measure, 1 tin tunnel, 2 desks, 1 grain box, 1 large map of main pipe, 1 10-foot ladder, 1 coal stove, 1 coal hod, 1 counter scale, 1 platform scale, 2 brooms, 4 chairs, 2 tanks for testing meters, 12 monkey wrenches, 4 Stillson wrenches. **Worthington Meters.**—2 2-inch, 2 1-2 inch. **Desper Meters.**—1 1-inch, 2 5/8-inch. **Duplex Meters.**—2 1-inch. **Fitts Rotary Meter.**—1 5/8-inch. **Crown Meter.**—10 1-inch, 23 3/4 inch, 13 5/8-inch.—**Second Hand Meters Ball and Fitts.**—3 5/8 inch. **Hydrant Packings.**—35 also 33 4-inch for tap, 33 4-inch for bottom, 34 5-inch for top, 36 5-inch for bottom, 10 packings for 4-inch gate, 12 for 6-inch gate, 6 for 8-inch gate, 3 for 12-inch, 1 for 16-inch gate,

## Tools at Filter Inlet.

2 iron tooth rakes, 11 shovels, 1 rammer, 1 axe, 2 ice chisels, 1 gate wrench, 1 nail hammer, 1 pick, 2 brooms, 1 wheelbarrow.

## Tools at Reservoir.

1 grindstone, 1 iron tooth rake, 2 hay forks, 1 manure fork, 4 shovels, 1 sod cutter, 1 axe, 2 hoes, 2 scythes, 2 snaths, 1 grass hook, 4 wheelbarrows, 1 coil rope, 3 thermometers, 1 snow shovel, 1 stop gate wrench, 1 sidewalk wrench, 1 ladder, 1 gallon japan, 1-2 bbl. linseed oil, 4 paint brushes, 5 paint pots.

## Property and Tools at Engine House.

1 vice, 1 work bench, 1 portable forge, 8 sets brasses for engine, 2 sets differential blocks, 1 piece 2-inch rope, 1 set fire irons, 1 brass hydrant, 3 axes, 11 wrenches, 1 hand-saw, 2 jack-screws, 2 cold chisels, 1 ratchet drill, 1 socket drill, 3 calking chisels, 1 barometer, 2 thermometers, 1 desk, 1 indicator, 1 oil cupboard, 2 oil dishes, 1 platform scale, 4 crowbars, 64 feet 5-8-inch chain, 16 eyebolts, 1 truck, 1 key wrench for air pump, 1 iron wheelbarrow, 2 hand-saws, 1 buck saw, 1 saw-horse, 2 gas lamps, 1 high grade thermometer, 4 brass bolts 1-2 inch diameter for pump valves, 5 spare pump valves, 5 sets spare weights for valves, 11 socket wrenches Morris engine, 11 finished wrenches Worthington engine, 3 sledge hammers, 10 drills, assorted sizes, 2 bit stocks, 3 bits, 1 25-foot ladder, 1 20-foot, 1 8-foot ladder, 1 pair steps, 1 hoe, 2 racks, 1 small die plate, 1 fore plane, 3 monkey wrenches, 100 ft. 2-in. rope, 4 chisel bars, 6 small taps, 4 finished socket wrenches Worthington engine, 1 14-quart iron pail, 4 hand hammers, 1 grindstone, 1 anvil, 7 pairs gas tongs, 1 wrench, 11 finished wrenches, 1 clock.

## Property in Water Board and Superintendent's Office.

16 chairs, 3 high stools, 1 letter press, 5 desks with drawers, 3 standing desks, 2 office tables, 1 book case, 1 clock, 5 ink stands, 1 glass mug, 4 maps of Lowell, 1 map of water-distributing pipes, 3 waste baskets, 2 mats, 3 hat-racks, 3 spittoons, 4 wrenches, 1 pick, 1 steel bar, 1 tin match safe, 1 lantern, 1 water gauge, 1 apparatus for sealing gates, 1 screw driver, 1 safe, 1 key rack, 1 shovel, 1 atlas of Lowell, 1 black walnut book case, 1 apparatus for testing capacity of engines

THIRTEENTH  
ANNUAL REPORT

OF 1885

★  
Lowell Water Board

TO THE

CITY COUNCIL,

ACCOMPANIED BY THE REPORTS OF THE CITY ENGINEER  
AND OF THE SUPERINTENDENT OF WATER WORKS,  
TO THE WATER BOARD.

JANUARY 12th, 1886.



LOWELL, MASS.

LESLIE STEVENS & CO. PRINTERS.

1886.



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OF THE  
**Lowell Water Board**  
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1886.

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## CITY OF LOWELL.

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IN COMMON COUNCIL, JAN. 15, 1886.

Read and sent up to the Board of Aldermen.

DAVID CHASE, *Clerk.*

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IN BOARD OF ALDERMEN, JAN. 15, 1886.

Read by title and ordered on file.

SAMUEL M. CHASE, *City Clerk.*

# CIVIL ORGANIZATION, LOWELL WATER WORKS.

From their commencement to Jan. 1, 1886.

## JOINT SPECIAL COMMITTEES.

1869.

Jonathan P. Folsom, mayor.  
Charles A. Stott, alderman.  
Cyrus H. Latham, alderman.  
William H. Anderson, councilman.  
Frederick T. Greenhalge, councilman.  
Albert A. Haggett, councilman.  
Edwin Lamson, councilman.

1871.

Edward F. Sherman, mayor.  
Albert A. Haggett, alderman.  
Henry P. Perkins, councilman.  
Jeremiah Crowley, councilman.  
William Dolbins, councilman.

1870.

Jonathan P. Folsom, mayor.  
Charles A. Stott, alderman.  
Albert A. Haggett, councilman.  
Wm. Kittredge, councilman.  
Wm. O. Fiske, councilman.

1872.

Josiah G. Peabody, mayor.  
Alexander G. Cumnock, alderman.  
Henry P. Perkins, councilman.  
Nathaniel C. Sanborn, councilman.  
Crawford Burnham, councilman.

## WATER COMMISSIONERS.

1870-71-'72.

Levi Sprague, chairman.  
Wm. E. Livingston.  
Henry H. Wilder, resigned Sept. 26, 1871.  
Samuel K. Hutchinson, elected to fill vacancy.

## WATER BOARD.

1873.

Levi Sprague, president, from the citizens.  
William F. Salmon, from the citizens.  
Jonathan P. Folsom, alderman.  
Nathaniel C. Sanborn, councilman.  
Nathan W. Frye, councilman.

1878.

Albert A. Haggett, pres., from the citizens.  
James W. Bennett, from the citizens.  
Horace R. Barker, alderman.  
John F. Kimball, councilman.  
Charles H. Harvey, councilman.

1874.

Levi Sprague, president, from the citizens.  
William F. Salmon, from the citizens.  
Nathaniel C. Sanborn, alderman.  
Nathan W. Frye, councilman.  
G. W. S. Hurd, councilman.

1879.

Albert A. Haggett, pres., from the citizens.  
James W. Bennett, from the citizens.  
Horace R. Barker, alderman.  
Edward B. Pierce, councilman.  
Robert G. Bartlett, councilman.

1875.

Geo. Runels, president, from the citizens, re-  
signed Nov. 9, 1875.  
Cyrus H. Latham, president *pro tem.*; from  
the citizens.  
Benjamin Walker, alderman.  
Albert A. Haggett, councilman.  
Earl A. Thissell, councilman.

1880.

Albert A. Haggett, pres., from the citizens.  
James W. Bennett, from the citizens.  
Robert Wood, alderman.  
Charles C. Hutchinson, Councilman.  
Edward B. Pierce, councilman.

1876.

Cyrus W. Latham pres., from the citizens.  
Earl A. Thissell, from the citizens.  
Albert A. Haggett, alderman.  
Benj. C. Dean, councilman, resigned May,  
1876.  
John F. Kimball, councilman, elected to  
fill vacancy.  
Orford R. Blood, councilman.

1881.

Albert A. Haggett, pres., from the citizens.  
James W. Bennett, from the citizens.  
Robert Wood, alderman.  
Charles C. Hutchinson, councilman.  
Samuel Hosmer, councilman.

1877.

Cyrus H. Latham, pres., from the citizens.  
Albert A. Haggett, from the citizens.  
Horace R. Barker, alderman.  
John F. Kimball, councilman.  
James W. Bennett, councilman.

1882.

Albert A. Haggett, pres., from the citizens.  
Charles C. Hutchinson, from the citizens.  
Thomas R. Garity, alderman.  
William N. Osgood, councilman.  
Frank Wood, councilman.



## WATER BOARD.

1883.

Albert A. Haggett, pres. from the citizens.  
 Chas. C. Hutchinson, from the citizens.  
 George W. Fifield, alderman.  
 Edward B. Peirce, councilman.  
 John J. Hogan, councilman.

1885.

Albert A. Haggett, pres. from the citizens.  
 C. A. R. Dimon, from the citizens.  
 James Francis, alderman.  
 Alfred M. Chadwick, councilman.  
 Arnold S. Welch, councilman.

1884.

Albert A. Haggett, pres. from the citizens.  
 C. A. R. Dimon, from the citizens.  
 George W. Fifield, alderman.  
 Edward B. Peirce, councilman.  
 John J. Hogan, councilman.

1886.

Walter Coburn, pres. from the citizens.  
 C. A. R. Dimon, from the citizens.  
 James Francis, alderman.  
 Arnold S. Welch, councilman.  
 Frank W. Howe, councilman.

*Investigations were made at various times, by order of the City Council for the introduction of pure water into the city, viz: By Joint Special Committees consisting of the following named citizens:*

1838.

Oliver M. Whipple, alderman.  
George Brownell, alderman.  
Thomas Hopkinson, councilman.  
Benjamin Walker, councilman.  
David Dana, councilman.

1839.

Oliver M. Whipple, alderman.  
John Clark, alderman.  
Thomas Hopkinson, councilman.  
Benjamin Walker, councilman.  
John Nesmith, councilman.

1846.

Jefferson Bancroft, mayor.  
Oliver M. Whipple, alderman.  
David Dana, alderman.  
John Avery, councilman.  
Otis L. Allen, councilman.  
Thomas Hopkinson, councilman.  
Ignatius Tyler, councilman.

1865.

George W. Norris, alderman.  
Edward F. Watson, alderman.  
Charles W. Dodge, councilman.  
T. L. P. Lamson, councilman.  
John Pearson, councilman.

1866.

Josiah G. Peabody, mayor.  
Charles W. Dodge, alderman.  
Joseph L. Sargent, alderman.  
Benjamin Walker, councilman.  
Edward C. Rice, councilman.

## WATER BOARD, 1886.

---

**President** . . . . **WALTER COBURN.**

Term expires first Monday in May, 1887.

**C. A. R. DIMON,**

Term expires first Monday in May, 1886.

**ALDERMAN JAMES FRANCIS.**

**Councilman ARNOLD S. WELCH.**

**Councilman FRANK W. HOWE.**

**Clerk** . . . **HORACE H. KNAPP.**

**Superintendent of Works** . . . . . **HORACE G. HOLDEN**

**Foreman of Works** . . . . . **THOMAS DOYLE.**

**Engineer at Pumping Station** . . . . . **JAMES P. ROBERTS.**

**Service Clerk** . . . . . **LEONARD T. FARRIS.**

*Inspectors.*

**JOHN J. BANCROFT.**


**ANDREW J. DEVOLL.**

**THOMAS E. LENNON.**

**WILLARD S. KNOWLTON.**

*Meter Inspector.*

**HENRY E. SPRAGUE.**

 The Water office is open daily, from 9 A. M. to 3 P. M., and on Monday evenings, from 7 to 8 o'clock.

## REPORT OF THE WATER BOARD.

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OFFICE OF LOWELL WATER BOARD,  
LOWELL, MASS., Jan. 12, 1886.

*To the City Council of the City of Lowell:*

GENTLEMEN—The Lowell Water Board in compliance with the Ordinances of the City of Lowell herewith present the Thirteenth Annual Report of the Board:

The year 1885 has been in the Water-Works department one of continued prosperity, and we are pleased to be able to report an increase of the net charges for water of nearly \$7,000 over the charges of 1884.

All departments of the Water-Works are in excellent condition, and are in charge of faithful men, who have been long in the service of the city, in this department.

For the details of work done by this department we would refer to the accompanying Reports of the Superintendent and Engineer.

This department has always been fortunate in having unanimity of action within the Board, every member taking a personal interest in the work of the department, so that a line of action, after careful consideration, being adopted, all have assisted to carry it forward to a successful result.

The first meeting of the Board for the year 1885, was held on the evening of January 12th, the board

being comprised of the following members: Albert A. Haggett, President; and Col. C. A. R. Dimon from the citizens; Alderman James Francis, Councilmen Alfred M. Chadwick and Arnold S. Welch from the City Council.

#### ORGANIZATION.

The annual organization of the Board, under the provision of the City Ordinance, occurred on May 4th, it being composed of the following members:

Col. C. A. R. Dimon from the citizens.

Walter Coburn                   “   “   “

Alderman James Francis.

Councilman Alfred M. Chadwick.

Councilman Arnold S. Welch.

On motion of Col. Francis the permanent organization of the Board was postponed until the evening of May 12th.

On the evening of May 12th, the whole Board being present, Walter Coburn was elected President of the Board, and Horace H. Knapp, Clerk.

#### CONTRACTS.

February 3rd a contract was made with R. D. Wood & Co., of Philadelphia, the lowest bidder for 100 tons of cast iron pipe at \$29.90 per ton of 2240 lbs. delivered in Lowell.

May 1st, proposals were received and opened from dealers in this city for 1200 tons of Powelton mine coal to be delivered and stored in the coal-house at the pumping station, and the contract was awarded to the lowest bidder, Whithed & Co., at \$4.17 per ton of 2240 lbs.

October 5th, a contract was made with Wm. H.

Ward to repair the Beacon Street Reservoir at the following rates, viz.:

For Hoisting Engines per day.. .. .	\$2.00
“ Steam Derricks “ “ .....	2.00
“ Hand “ “ “ .....	1.00

All wheelbarrows, dirt boxes, chains, bars, picks and shovels, mortar boxes, etc., per day, \$1.00, and a commission of 15 per cent. on actual cost of labor of teams and men, for superintendence.

#### STATISTICS.

The total amount of water pumped during the year was 1,299,730,280 U. S. gallons, against 1,105,277,600 U. S. gallons in 1884, and the daily average pumped was 3,560,904 gallons, against 3,157,936 in 1884, an increase for the year of 194,452,680 gallons, and of 402,968 gallons in the daily average.

The quantity of coal consumed during the year for all purposes, excepting for the High Service Supply was 1,219 $\frac{8}{10}$  tons against 1042 $\frac{11}{10}$  tons in 1884. For the High Service supply the consumption during the year was 28 $\frac{11}{10}$  tons against 30 $\frac{3}{10}$  tons in 1884.

There have been 532 $\frac{1}{10}$  gallons of water raised 160 $\frac{1}{10}$  feet high for each pound of coal consumed during the year.

There are now laid 79 $\frac{1}{10}$  miles of street mains, the increase for the year having been 2 $\frac{1}{10}$  miles. The total net charges for water rates for the year after deducting all abatements, and the charges for service pipes, have been \$153,748.32 against \$145,999.93 for the year 1884, an increase for the year of \$7,748.39.

The following table will show the monthly charges for water, from the commencement of the Works to December 31st, 1885, with all abatements, and total net charges:—

**Charges for Water by Months, from Commencement to December 31, 1885.**

MONTHS.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.
January . . . .	\$ 363 94	\$ 418 96	\$ 126 51	\$ 169 14	\$ 232 44	\$ 233 73	\$ 182 58	\$ 253 87	\$ 271 52	\$ 472 76	\$ 702 05		
February . . . .	35 53	233 43	86 84	144 38	238 19	349 08	146 40	139 22	136 06	347 66	352 90		
March . . . .	\$ 6,124 94	50,200 10	65,417 08	82,249 51	89,177 52	82,225 43	80,003 69	80,567 44	89,210 88	90,856 37	98,092 13	102,961 30	
April . . . .	785 86	1,739 56	935 20	265 34	584 11	1,070 12	9,242 84	6,478 89	540 20	403 64	263 10	351 73	439 61
May . . . .	2,983 16	3,274 09	2,147 96	874 47	1,819 65	1,121 43	2,731 35	1,476 15	879 61	1,191 41	984 84	1,495 90	1,062 34
June . . . .	5,318 78	2,805 86	2,887 43	4,490 91	2,389 52	3,903 69	6 126 86	898 08	12,574 25	16,401 62	17,757 44	18,769 27	21,203 61
July . . . .	4,835 52	1,889 63	1,926 31	582 68	3,147 78	1,261 24	1,213 13	11,457 84	273 00	959 8	1,059 37	899 21	1,053 86
August . . . .	2,728 30	498 50	449 86	771 87	799 88	677 01	563 35	459 17	514 46	654 40	902 76	984 17	828 40
September . . . .	2,927 07	3,245 06	865 90	495 97	3,493 90	4,908 07	6,584 86	8,108 23	10,088 19	10,904 30	12,467 32	12,939 94	13,452 16
October . . . .	9,729 05	872 10	2,947 93	4,893 44	543 79	663 80	454 29	*338 51	369 22	552 27	941 81	733 12	697 87
November . . . .	761 21	634 63	573 35	1,445 65	518 72	1,220 27	1,403 89	620 56	873 16	378 97	1,615 65	693 41	477 10
December . . . .	1,571 72	3 689 70	3,955 59	3,246 39	4,040 71	4,522 75	5,704 77	7,851 52	9,593 32	10,848 08	12,512 70	12,544 55	12,617 45
Totals . . . .	\$39,168 64	\$69,307 30	\$82,891 60	\$99,674 93	\$98,178 93	\$102,877 32	\$115,261 20	\$118,808 70	\$125,975 27	\$133,503 43	\$143,869 22	\$148,923 83	\$155,848 98
Less abatements to date . . . .		1,872 83	640 04	8,185 88	2,592 65	4,343 13	9,900 05	1, 02 13	3,766 88	2,490 50	3,694 15	4,314 79	2,100 66
Net amounts . .	\$39,168 16	\$67,434 50	\$82,221 54	\$91,489 05	\$95,676 28	\$98,534 19	\$105,671 15	\$117,106 57	\$122,208 39	\$131,012 93	\$140,775 07	\$144,614 06	\$153,748 32

## FINANCIAL STATEMENT.

The total gross amount of bills sent to the City Treasurer for collection for this department for the year ending Dec. 31, 1885, is as follows, viz:

For Water Rates .....	\$92,565.17	
Metered water.....	63,283.81	
Total for the use of water.....		\$155,848.98
For service pipe and laying.....	\$1,636.70	
Meters sold.....	2,275.50	
Sundry accounts.....	3,101.61	7,013.81
Total charges for the year.....		\$162,862.79

The following statement exhibits receipts and expenditures for the year, the net cost of the Water Works, including the interest on the Water Loan, and all expenses in excess of receipts for water rates; also the total cost and expenses of the Works by taxation:

Net cost of Water Works to Jan. 1, 1885, as per last annual report .....	\$2,370,294.37
--	----------------

Expended during the year for Water pipes, and for laying the same, and all other items of

## CONSTRUCTION.

## MATERIALS FOR MAINS, SERVICES, &amp;c. :—

Cast-iron pipe.....	\$4,094.36
Cast-iron specials..	319.96
Wrought-iron pipe and fittings.....	776.70
Iron castings.....	170.76
Brass castings.....	22.12
Lead pipe.....	1,296.17
Lead pig.....	296.55
Tin pig.....	21.24
Powder, fuse, &c., .....	76.40
Stop and waste cocks .....	836.28
Hardware.....	100.45
Teaming pipe.....	123.08
Lumber.....	244.56
Freight.....	314.29

*Amounts carried forward,*

\$8,692.92 \$2,370,294.37



<i>Amounts brought forward,</i>	\$8,692.92	\$2,870,294.37
Wood.....	26.00	
Tinning couplings.....	3.34	
Kyanizing boards.....	40.61	
Cement.....	1.24	
Charcoal.....	2.40	
Concrete.....	39.25	
Damage.....	1.00	
Service boxes.....	308.41	
Water gates.....	723.50	
Hydrants .....	668.20	
Hydrant repairs.....	5.75	
Hydrant castings.....	163.58	
Hydrant freight.....	20.24	
	<u>\$10,696.44</u>	

## LABOR, PAY-ROLL ON ACCT. OF—

Extensions.....	\$1,969.97	
Services .....	1,144.89	
Piping .....	773.56	
Foreman.....	870.17	
		<u>\$4,758.59</u>
		<u>\$15,453.03</u>

## MAINTENANCE.

Expended for repairs, current expenses, pumping, &c., viz :—

## REPAIRS.

Iron, steel, &c.,.....	\$256.76	
Brass castings.....	104.01	
Tools, purchased and repaired.....	90.61	
Hardware.....	105.72	
Lumber .....	138.18	
Leather .....	9.17	
Teaming.....	25.43	
Clay pipe.....	4.40	
Cleaning conduit.....	15.55	
Rubber boots.....	60.25	
Brick.....	2.40	
Sundries.....	139.85	
Labor pay-roll.....	4,872.53	
Labor.....	167.51	
	<u>\$5,992.37</u>	
Total repairs.....	<u>\$5,992.37</u>	

*Amount carried forward,*

\$2,370,294.37

# REPORT OF THE WATER BOARD.

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*Amount brought forward,*

\$2,370,294.37

## CURRENT EXPENSES. Pay-roll.

Salaries.....	\$1,893.55	
Inspection.....	2,805.28	
Clerk hire.....	2,845.54	
City Engineer.....	669.55	
	<hr/>	\$8,213.92

## Materials.

Printing, stationery, &c.....	396.11
Postage stamps.....	29.80
Travel and express.....	80.84
Sundries, office.....	102.65
Telephone .....	255.25
Analyses of Water.....	100.00
Flushing sewers.....	33.00
Rent of water office.....	75.00
Coal.....	5.50
Corn, oats, straw, &c.....	230.03
Gas.....	1.86
Sundries, pipe yard. ....	96.95
Horse shoeing.....	53.97
Repairing wagons.....	210.18
Repairing harnesses.....	68.65
Horse, wagon, sleigh and harness.....	386.00
Lumber (fence at pipe yard).....	110.54
Labor at pipe yard.....	65.58

Total current expenses.....\$10,515.83

## PUMPING ACCOUNT.

Coal.....	\$5,113.69
Labor pay-roll.....	3,757.11
Labor.....	48.69
Steam indicator.....	63.00
Felting .....	27.51
Iron, steel, &c.....	148.16
Packing.....	26.88
Oil.....	151.38
Gas .....	127.12
Wood .....	9.89
Freight.....	1.05
Brooms .....	4.50
Lumber....	3.41
Printing.....	7.75
Sundries.....	84.73
Soap.....	5.44

*Amounts carried forward,*

\$9,580.31 \$2,370,294.37

<i>Amounts brought forward,</i>	\$9,580.31	\$2,379,294.37
Files.....	3.45	
Re-tubing boiler.....	100 00	
Iron bedstead and mattresses.....	25.50	
Cotton waste.....	27.13	
Rubber valves.....	41.18	
Total pumping account.....	<u>\$9,777.57</u>	
<b>METER ACCOUNT.</b>		
Meters purchased.....	\$1,411.78	
Labor pay-roll.....	\$2,490.47	
Repairs on meters.....	749.11	
Freight .....	42.93	
Supplies.....	7.80	
Unions .....	42.75	3,333.06
Total meter account.....	<u>\$4,744.84</u>	
<b>RESERVOIR, BEACON STREET.</b>		
Manure.....	\$20.00	
Plowing and sowing.....	8.00	
Cleaning vault.....	6.00	
Wall paper.....	7.00	
Cutting and storing hay.....	113.25	
Expenses wounded men.....	14.30	
Lumber.....	174.71	
Police services.....	62.50	
Printing.....	20.75	
Oil, waste, tallow, &c.....	15.79	
City Engineer (expense to New York).....	17.68	
Slate.....	2.64	
Mason work (dry wall).....	1,037.73	
Stone chips.....	47.50	
Cement.....	123.42	
Teaming.....	1,202.38	
Freight.....	191.99	
Gravel.....	202 40	
Granite.....	736 44	
Rebuilding (Ward contract).....	9,842.57	
Construction of telephone.....	31.91	
Telephone.....	30.00	
Analyses of soil.....	20.00	
Stove, &c.....	8.72	
Photography.....	53.65	
Labor, pay-roll.....	605.37	
Labor.....	139.57	
Total Beacon Street Reservoir acct.....	<u>\$14,766.27</u>	
<i>Amount carried forward,</i>		\$2,370,294.37

# REPORT OF THE WATER BOARD.

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<i>Amount brought forward,</i>	<b>\$2,370,294.37</b>
<b>RESERVOIR, HIGH SERVICE.</b>	
Land, Milton Fox.....	\$2,500.00
Interest, " " .....	278.33
<b>Total High Service Reservoir acct.....</b>	<b>\$2,778.33</b>

## RECAPITULATION.

<b>Total construction account .....</b>	<b>\$15,455.03</b>
" repairs.....	\$5,992.37
" Current expense.....	10,515.88
" Pumping.....	9,777.57
" Meter.....	3,326.25
" Reservoir (Beacon Street)....	14,766.27
" " (High Service)....	2,778.33
<b>Total maintenance account.....</b>	<b>\$ 47,156.62</b>
<b>Meters purchased.....</b>	<b>1,418.59</b>
<b>Amount expended for the year exclusive of in'er st...</b>	<b>\$61,030.24</b>
<b>Interest paid during the year .....</b>	<b>111,850.00</b>
<b>Total expenditures for the year.....</b>	<b>\$175,880.24</b>
	<b>\$2,546,174.61</b>

## CREDITS.

<b>Amounts received by the City Treasurer during the year for water rates, service pipes and sundries, viz :</b>	
For account of 1884.....	\$ 15,020.36
" " 1885 .....	142 936.43
<b>Total receipts for the year.....</b>	<b>\$157,956.79</b>
<b>Net cost of works, including interest on Water Loan to Jan. 1, 1886.....</b>	<b>\$2,388,217.82</b>
<b>Present debt of the city, by bonds and notes, on account of construction of Water Works.....</b>	<b>\$1,890,000.00</b>
<b>Total amount paid from the City Treasury to Jan. 1, 1886, by taxation on account of Water Works, in excess of receipts from Loans and water rates</b>	<b>\$513,217.82</b>
<b>Value of Water Works Sinking Funds, Jan. 1, 1886</b>	<b>511,557.96</b>
	<b>\$1,024,775.78</b>
<b>Net cost of Works, including interest on Water Loan to Jan. 1, 1886</b>	<b>\$2,388,217.82</b>
<b>Whole amount paid by taxation, and by appropriation for the sinking Funds, and the value of the accumulation of said Funds, Jan. 1, 1886</b>	<b>\$1,024,775.78</b>
<b>Debt of the city on account of Water Works, in excess of Water Works Sinking Funds, Jan. 1, 1886</b>	<b>\$1,363,442.04</b>

The following table will show the gross cost of the Water Works, yearly, from the commencement of the same to Jan. 1st, 1886 :

Expended in	1870	\$ 95,057.00
"	1871	624,151.66
"	1872	560,708.40
"	1873	349,717.87
"	1874	233,370.63
"	1875	275,660.78
"	1876	221,502.24
"	1877	163,814.28
"	1878	158,510.15
"	1879	150,047.82
"	1880	154,391.59
"	1881	231,171.27
"	1882	173,645.92
"	1883	179,713.23
"	1884	174,552.71
"	1885	175,880.24
Gross cost of Works to Jan. 1, 1886,		<u>\$3,921,895.79</u>
Receipts from various sources to Jan. 1, 1886,		<u>1,533,677.97</u>
Net cost of Works to Jan. 1, 1886,		<u>\$2,388,217.82</u>

# REPORT OF THE WATER BOARD.

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The following table will show the expenditures and receipts of the Works from 1873 to 1886, exclusive of the interest on the Water Debt:

	Expenditures.	Receipts.	Expenditures in excess of receipts.	Receipts in excess of expenditures.
1873	\$188,376.59	\$ 57,739.48	\$180,637.11	
1874	128,105.63	80,625.66	47,479.98	
1875	170,095.78	94,908.14	75,187.64	
1876	115,012.24	98,815.54	16,196.70	
1877	53,988.72	100,826.63		\$46,837.91
1878	49,900.15	104,142.87		54,242.72
1879	42,157.82	110,185.34		68,027.52
1880	45,031.59	123,740.49		78,708.90
*1881	121,601.27	128,053.97		6,452.70
†1882	64,525.92	140,397.96		75,872.04
1883	65,673.23	152,582.99		86,909.76
1884	64,982.71	154,437.55		89,454.84
‡1885	64,030.24	157,956.79		93,926.55

\* In 1881 there were expended the following extraordinary amounts :

For River crossing, 24 inch reserve line	\$ 9,988.59
For High Service Water supply	57,969.39
† In 1882, High Service Water supply	10,898.59
‡ In 1885, Beacon Street Reservoir	14,766.27

Had these extraordinary expenses not occurred, the excess of receipts over expenditures for those years would have been respectively \$74,410.68, \$86,770.63 and \$108,692.82.

This department received an appropriation of only \$3000 from the City Council of 1885, and \$2700 of this was used to settle land damages of the High Service Reservoir. So that the department was virtually self-sustaining, and had not the expense of repairing the break at the Beacon Street Reservoir been incurred, the department would have earned a net profit to the city above expenses and interest on the Water Debt.

But an excess of earnings over expenses can not at present be used to reduce the Water Rates, as there are many improvements yet to be made to perfect our system, which can now be done without enlarging our present debt.

As President Haggett remarked in his report of 1884, "the time is near at hand (1890) when the Water Debt can be refunded, and the item of interest on the Water Debt be materially reduced." When that time arrives it should be the policy of the Water Board to reduce the Water Rates, which even now are below the rates of most cities.

Superintendent Holden has attended to the duties of his position faithfully under constant strain of responsibility by day and by night.

H. H. Knapp, the Clerk of the board, has faithfully attended to the office duties. The condition of the records, the attention given to delinquent water-takers, and the small amount of unpaid Water Rates, attest his vigilance, business methods and attention to duty.

The Inspectors, whose duties have been increased, without detriment to the department, have attended to those duties, and take a personal interest in everything that is for the benefit of the department.

For the report on the Sliding of the Paving at the Beacon Street Reservoir, we would refer you to the accompanying Report of the Engineer in charge.

The thanks of the citizens of Lowell and of this Board are due to Messrs. Davis and Francis, Consulting Engineers, and also to the City Engineer, Mr. Evans who devoted his best thought and talents to the work, and it reflects great credit on his ability, that all of his suggestions received the unqualified approval of the eminent Consulting Engineers.

The Pumping Station is in perfect condition, under the watchful care of our Engineer, Mr. Roberts, whose long and faithful services need no word of commendation from us.

We would recommend that in the near future, as soon as the net receipts have reached a certain point, that increased facilities for filtering be supplied, that all the water used may be filtered. This growing need, we trust, will suggest itself to future Boards.

The Ordinance Licensing Plumbers and Pipe Fitters, has during the year been made a part of the Ordinances of the City of Lowell. And the Board turn over to our successors the duty of promulgating rules and regulations which shall govern Plumbers and Pipe Fitters in their work in connection with the City Water Works.

Under the protecting care of the City Council of 1885, the Water department now occupy commodious departments on the ground floor of the Government Building supplied with a fire-proof vault, where the valuable Records of the Department may be safely kept, relieving us of constant anxiety, that in case of



fire in the building, Records representing thousands of dollars to the City, would be destroyed.

We commence another year with every prospect of continued prosperity.

Respectfully submitted,

WALTER COBURN,  
CHAS. A. R. DIMON,  
A. M. CHADWICK,  
JAMES FRANCIS,  
ARNOLD S. WELCH,

*Members of the Lowell Water Board.*

IN WATER BOARD, JAN. 12, 1886.

Read and accepted, and ordered to be transmitted to the City Council.

Attest:

HORACE H. KNAPP,  
*Clerk.*

CITY TREASURER OF LOWELL IN ACCOUNT WITH LOWELL WATER WORKS.

Dr.		Cr.	
1885.		1885.	
Jan.	To appropriation \$ 3000.00	By payments during the year, viz :	
"	" Water receipts 6,692.73	Interest.	Salaries. Drafts. Refunds.
Feb.	" " 6,092.13	\$ 3,210	\$158.33 \$2,593.44
Mar.	" " 1,794.98	330	158.34 4,545.45
Apr.	" " 4,639.10	300	158.33 1,769.00
May	" " 28,721.54	1,745	158.33 2,179.86
June	" " 53,033.26	46,870	151.89 2,998.74 \$991.90
July	" " 21,114.51	5,630	158.33 7,028.21 2.75
Aug.	" " 12,793.84	1,140	158.33 5,993.59 88.85
Sept.	" " 6,225.18	420	158.34 5,932.38 8.82
Oct.	" " 7,499.53		158.33 3,908.35
Nov.	" " 6,903.19	1,685	158.33 10,908 37
Dec.	" " 3,584.12	44,350	158.34 9,858.56
"	Overdraft 42.00	6,170	158.33 4,420.74
"	Reservoir Loan 15,000.00		
		\$111,850	\$1,893.55 \$62,136 69 \$1,092.32
		Bal.	\$176,972.56 163.55
	\$177,136.11.		\$177,136.11



THIRTEENTH ANNUAL REPORT  
OF THE  
City Engineer to the Water Board.

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JANUARY 1, 1886.



## REPORT OF THE ENGINEER.

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OFFICE OF CITY ENGINEER,  
LOWELL, MASS., JAN. 1, 1886.

*To the Lowell Water Board:*

GENTLEMEN: -The undersigned respectfully submits the Thirteenth Annual Report of the work done by the Pumping Engines at the Pumping Station, and the Records, as taken at the Beacon Street Reservoir. The calculations of the duty of the engines were made from the records kept by Mr. James P. Roberts, the engineer in charge.

All the coal used at the station has been charged to pumping, and no deduction has been made; and in the calculation of the duty nothing has been added for friction in the pump.

During the year the Morris engine has run one hundred and thirty-seven and the Worthington forty-five nights. March 24th, the Morris engine pumped 5,952,640 gallons, and April 30th the Worthington engine pumped 5,665,250 gallons, which is the largest quantity pumped during any run of twenty-four hours this year.

In the table of the running expenses of the engines the amounts will not agree with the pumping account as given in the report of the Water Board, for the reason that only the articles used during the year are included. The Morris engine having pumped eighty-four per cent. of all the water; eighty-four per cent. of the pay, cylinder and crude oil, waste, repairs on boilers, tools and sundries, in the running expenses, has been charged to the Morris engine, and the balance to the Worthington engine, this being considered a just division.

The average cost of pumping one million gallons from the low-service reservoir to the high-service reservoir is nine dollars and twelve cents, which added to the cost of raising the same quantity into the low-service reservoir, makes the total cost of raising one million gallons into the high-service reservoir sixteen dollars and forty-one cents.

Table Showing Work Done with Morris Engine (Beam and Fly Wheel) and Boilers for each Month during the year 1885.

MONTHS.		No. of days Pumping.	Ave No. of hours Pumping per day.	Number of hours Pumping per Month.	Number of Strokes made per month.	Average No. of strokes per minute.	Average head including friction in feet.	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. gallons.	No. gal. of water raised in pump to test per ton of total coal consumed.	Duty in lbs., 100 lbs. of coal, raised in pump only, deduction for ashes or clinkers.	Duty on total coal consumed.
January	. . .	27	18-59	512-45	389,512	12.66	164.28	124,643,840	4,616,438	553.	90,196,125	75,777,562
February	. . .	28	20-31	574-20	437,000	12.68	164.38	139,840,000	4,994,285	561.	91,225,149	76,875,140
March	. . .	27	18-29	499-15	378,141	12.62	164.58	121,005,120	4,481,671	556.	90,670,225	76,326,435
April	. . .	16	16-38	266-15	201,422	12.61	163.98	64,455,040	4,028,440	564.	92,799,058	77,118,584
May	. . .	10	19-26	194-20	147,096	12.62	164.38	47,070,720	4,707,072	557.	93,050,809	76,312,671
June	. . .	26	16-55	439-45	329,368	12.48	164.38	105,397,760	4,033,760	557.	90,953,661	76,335,679
July	. . .	21	20-44	435-35	327,901	12.55	163.68	104,928,320	4,996,587	553.	90,878,520	75,452,657
August	. . .	23	17-13	396-05	298,502	12.56	163.38	95,520,640	4,153,071	555.	90,698,572	75,617,318
September	. . .	23	15-29	356-15	268,258	12.55	164.38	85,842,560	3,732,286	557.	91,424,553	76,249,367
October	. . .	20	9-30	181-00	95,459	8.79	147.74	30,546,880	1,527,344	556.	69,792,743	68,521,251
November	. . .	20	15-13	304-25	216,242	11.84	158.64	69,197,440	3,459,872	567.	89,780,506	74,927,984
December	. . .	24	18-16	438-15	328,022	12.47	163.78	104,967,040	4,373,627	557.	90,909,884	75,967,113
Totals and averages		265	17-21	4598-15	3,416,928	12.38	162.30	1,093,415,360	4,126,096	558.	89,735,245	75,409,571

**Table showing work done with Worthington High-Service Engine, 1885.**

MONTHS.	No. of days Pumping.	Average number of hours Pumping per day.	Number of hours Pumping per month.	Number of strokes made per month.	Average number of strokes made per minute.	Average head, including friction in feet.	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. gallons.	No. of gallons of water pumped into reservoir per lb. of total coal consumed.	Coal in lbs used when pumping.
January . . . .	4	h. m. 11-37	46-30	85,960	30.81	77.79	1,208,440	300,860	318	3,780
February . . . .	4	11-07	44-30	83,787	31.38	78.09	1,178,018	293,254	321	3,650
March . . . . .	4	11-54	47-35	105,079	36.80	78.67	1,471,106	367,776	320	4,600
April . . . . .	3	14-50	44-30	92,477	34.64	78.67	1,294,678	431,559	313	4,140
May . . . . .	4	10-58	43-50	91,602	34.83	78.09	1,282,428	320,607	327	3,920
June . . . . .	4	15-35	62-20	137,070	36.65	78.67	1,918,980	479,745	325	5,900
July . . . . .	5	12-24	62-00	147,919	39.76	78.67	2,070,866	414,173	305	6,800
August . . . . .	4	14-15	57-00	128,330	37.52	78.67	1,796,620	449,155	327	5,500
September . . . .	4	15-00	60-00	117,858	32.74	78.67	1,650,012	412,503	324	5,100
October . . . . .	11	8-25	92-30	125,892	22.68	80.77	1,762,488	160,226	326	5,400
November . . . .	7	9-31	66-40	116,308	29.08	81.31	1,628,312	232,616	313	5,206
December . . . .	2	18-15	36-30	81,435	37.18	78.67	1,140,080	570,045	319	3,570
Totals and averages.	56	11-51	663-55	1,313,717	32.98	78.89	18,392,038	328,429	319	57,566



**Table Showing Amount of Coal Used for Morris Engine at Pumping Station  
During the Year 1885.**

MONTHS.	COAL CONSUMED.			
	For starting fires in Pounds.	When pumping in Pounds.	For banking fires in Pounds.	Total per Month in Pounds.
January . . .	26,400	189,200	9,600	225,200
February . . .	29,400	210,000	9,800	249,200
March . . . .	25,200	183,050	9,200	217,450
April . . . .	13,500	94,920	5,800	114,220
May . . . . .	10,200	69,300	5,000	84,500
June . . . . .	22,200	158,750	8,200	189,150
July . . . . .	22,800	157,500	9,400	189,700
August . . . .	20,400	143,400	8,200	172,000
September . .	18,600	128,630	7,000	154,230
October . . . .		53,890	1,000	54,890
November . .	14,400	101,900	5,800	122,100
December . .	22,200	157,600	8,800	188,600
Totals . . . .	225,300	1,648,140	87,800	1,961,240

**Table Showing Amount of Coal Used for Worthington Duplex Engine at  
Pumping Station During the Year 1885.**

MONTHS.	COAL CONSUMED.			
	For starting fires in Pounds.	When pumping in Pounds.	For banking fires in Pounds.	Total per month in Pounds.
January . . . .				
February . . . .				
March . . . . .				
April . . . . .	9,300	57,380	2,200	68,880
May . . . . .	15,300	87,200	4,400	106,900
June . . . . .				
July . . . . .				
August . . . .	2,700	16,800	600	20,100
September . .				
October . . . .		148,900		148,900
November . .	6,900	105,100	3,800	115,800
December . .	2,700	16,300	600	19,600
Totals . . . .	36,900	431,680	11,600	480,180

Table showing work done with Worthington Duplex Engine for each month during the year 1885.

MONTHS.	No. of days Pump- ing.	Ave. No. of hours Pumping per day.	No. of hours Pumping per month.	No. of strokes made per month.	Ave. No. of strokes made per minute.	Ave. No. Ave. head of strokes including friction in feet.	Quantity pumped per month in U. S. gallons.	Ave. quantity pumped per day in U. S. gallons.	No. gal. of water raised in reservoir per vol. of total coal consumed.	Duty in lbs. per foot high, with 100 lbs. coal used only, no deduction for ashes or clinkers.	Duty on total coal consumed
January . . . .											
February . . . .											
March . . . . .											
April . . . . .	9	13-48	124-15	93,756	12.58	166.19	29,064,360	3,229,373	422.	70,155,010	58,442,130
May . . . . .	13	15-12	197-35	145,559	12.28	165.99	45,123,290	3,471,022	422.	71,584,614	58,392,687
June . . . . .											
July . . . . .											
August . . . . .	3	12-00	36-00	270,50	12.52	164.59	8,385,500	2,795,166	417.	68,466,254	57,225,526
September . . . .											
October . . . . .	28	17-20	485-30	206,553	7.09	147.06	64,031,430	2,286,837	430.	52,704,369	52,704,369
November . . . .	22	15-23	338-25	165,713	8.16	157.55	51,371,030	2,365,047	444.	64,178,187	58,248,074
December . . . .	3	10-58	32-55	269,01	13.62	163.18	8,339,310	2,779,770	425.	69,576,552	57,862,136
Totals and Averages.	78	15-34	1214-40	665,532	9.13	160.76	206,314,920	2,645,063	430.	64,032,467	57,564,938

## PUMPING STATION, MORRIS ENGINE.

*Running Expenses for the year 1885.*

Pay of engineers and firemen.....	\$3,122 37
599 $\frac{1000}{1000}$ tons coal (Powelton) 1884, at \$4.44.....	2,661 85
17 $\frac{1000}{1000}$ tons coal (Cumberland) 1885, at \$4.31.....	76 59
363 $\frac{970}{1000}$ tons coal (Powelton) 1885, at \$3.72.....	1,351 61
2½ cords wood at \$4.00.....	10 00
Gas for lighting works.....	91 89
45 pounds tallow at 12c.....	5 40
131 gallons cylinder oil, at 65c.....	85 15
65½ gallons crude and cold test oil, at 26 $\frac{1}{10}$ c.....	17 29
7 gallons lard oil.....	4 80
18 gallons paraffine oil.....	3 10
185 lbs. cotton waste, at 12½c.....	23 13
36 lbs. soapstone packing, at 30c.....	10 80
17 lbs. flax packing, at 35c.....	5 95
Repairs on engine.....	38 04
Repairs on boilers, including heater.....	164 82
Tools, including Tabor indicator.....	61 75
Sundries.....	42 13
Total.....	<u>\$7,779 67</u>
Cost of raising water into reservoir, per million gallons.....	87 12
Cost of raising water one foot high, per million gallons.....	.04 $\frac{17}{100}$

## WORTHINGTON ENGINE.

*Running expenses for the year 1885.*

Pay of engineers and fireman.....	\$594 74
87 $\frac{1000}{1000}$ tons coal (Powelton) 1884, at \$4.44.....	390 23
152 $\frac{1000}{1000}$ tons coal (Powelton) 1885, at \$3.72.....	566 18
One-half cord wood.....	2 00
Gas for lighting works.....	31 63
25 gallons cylinder oil, at 65c.....	16 25
12 gallons crude and cold test oil, at 26 $\frac{1}{10}$ c.....	3 17
35 lbs. cotton waste, at 12½c.....	4 38
7 lbs. soapstone packing, at 30c.....	2 10
8½ pounds asbestos packing, at 28c.....	2 38
Repairs on engine, felting cylinder.....	32 39
Repairs on boilers, including heater.....	31 40
Tools, including Tabor indicator.....	11 76
Sundries.....	8 02
Total.....	<u>\$1,696 63</u>
Cost of raising water into reservoir, per million gallons.....	\$8 22
Cost of raising water one foot high, per million gallons.....	.05 $\frac{17}{100}$

## RESERVOIR, 1885, BEACON STREET.

The following table shows the average depth of water, the number of gallons, and the temperature of the water in the reservoir, and also the temperature of the air for each month. The temperature of the water was taken at 6 A. M. and 6 P. M., and of the air at 6 A. M., 1 and 6 P. M.

MONTHS.	Depth in Feet.	Quantity in U. S. Gallons.	Temperature in Degrees.	
			Of Water.	Of Air.
January.....	18.11	27,425,970	33.37	24.82
February .....	18.45	27,986,140	33.00	19.01
March.....	18.22	27,599,570	33.74	27.15
April.....	18.04	27,302,110	42.05	49.06
May.....	18.32	27,762,340	56.10	57.21
June .....	18.02	27,264,960	68.37	71.04
July.....	18.15	27,483,800	74.85	75.21
August.....	17.86	27,012,160	71.87	69.24
September.....	17.64	26,643,400	62.71	61.31
*October .....			53.58	51.80
*November.....			42.26	42.41
December .....	16.98	25,568,990	33.98	30.73

\*Reservoir being cleaned and repaired.

Table showing the average monthly and daily consumption of water for the year 1885 :

MONTHS.	Gallons per month.	Gallons per day.
January .....	128,269,760	4,137,730
February .....	137,899,390	4,924,980
March.....	121,144,650	3,907,890
April.....	93,100,400	3,103,350
May.....	92,891,640	2,996,500
June.....	103,294,290	3,443,140
July.....	109,923,630	3,545,920
August.....	102,399,040	3,303,190
September .....	97,308,725	3,243,620
*October.....	110,604,320	3,567,880
November .....	93,763,433	3,125,447
December.....	109,976,190	3,547,620
Total and average.....	1,300,575,470	3,563,220

\*About  $4\frac{1}{4}$  feet in depth, wasted from reservoir.

The following table shows the cost of coal, cost to pump one million gallons of water into the reservoir, and the total quantity pumped since the works were completed :

YEARS.	MORRIS ENGINE.			WORTHINGTON ENGINE.		
	Average cost of coal per ton.	*Cost to Raise 1,000,000 galls. of water into reservoir.	Total quantity of water pumped.	Average cost of coal per ton.	*Cost to raise 1,000,000 galls. of water into reservoir.	Total quantity of water pumped.
1873	\$8.63	\$31.88	186,683,700			
1874	7.85	21.25	288,060,990			
1875	7.81	14.33	445,017,090			
1876	6.83	11.54	397,768,750	\$6.94	\$14.68	145,698,140
1877	6.43	10.71	553,887,540	6.50	13.05	41,559,530
1878	5.48	9.13	653,323,140	5.51	11.77	36,593,020
1879	4.89	8.69	652,166,530	4.92	9.87	86,863,860
1880	4.42	7.84	771,500,100	4.49	9.48	52,100,770
1881	5.27	†9.72	718,721,320	5.81	9.88	156,275,340
1882	5.24	8.73	773,749,760	5.18	9.12	186,181,970
1883	5.12	8.55	803,694,400	5.35	10.66	238,796,100
1884	4.70	7.88	931,831,360	4.84	†11.62	173,446,240
1885	4.17	7.12	1,093,415,360	3.98	8.22	206,314,920

\*Not including interest on works.

†Extraordinary repairs.



## BEACON STREET RESERVOIR.

During the time the water in the reservoir was being drawn off by City consumption for the purpose of cleaning the basin, nearly one-half of the granite paving on the north slope started at 3 p. m., October 2nd, 1885, and slid partially down, making a diamond shaped breach one hundred and fifty feet in length and eight wide in the widest part. The water at this time had been drawn down to seven feet in depth.

October 4th, at 3 p. m., the paving on the west slope adjoining the Gate House on the south side slid down and piled up on the bottom of the reservoir. This slide was one hundred and fifty-seven feet in length. The next forenoon at 11 o'clock a section of paving on the west slope one hundred and fifty feet in length started from a point forty-five feet south of the northwest corner and sliding into the reservoir about twenty-four feet from the foot of the slope ploughed up the bottom puddle into quite a ridge. At this time the water was about two feet deep.

When the pump stopped delivering water into the reservoir, September 26th, the depth of water was about nineteen and one-half feet. Since the reservoir was completed thirteen years ago, the water has never been less than eleven feet deep.

When the water was drawn down, the banks were so thoroughly saturated and the bottom puddle had become so softened as to offer no resistance, and the slope puddle acting as a lubricant allowed the paving to slide.

In no case did the slides break back of the original face of the slope in the rear of the puddle lining, and above the original surface the puddle on the embankment remained nearly as originally laid. All of the material for the puddle on the slopes and bottom was selected from the excavation and is known as "hard pan" or puddling gravel.

An analyses of the material by Mr. W. P. Atwood, chemist, since the accident show it to be composed largely of fine sand mixed with gravel and clay, the proportion of clay being about nine per cent.

Seven derricks were placed on top of the embankments, and the hoisting out of the material was begun October 8th, by Mr. Wm. H. Ward, the well known contractor. All of the soft and mirey puddle was taken out, and the space below the base of the embankment was filled with fine bank gravel to the original slope, and on the embankment where any filling was required the gravel was thoroughly mixed with one-third of the old puddle.

It being very difficult to procure pure clay in time for the work so as not to delay the paving, and the difficulty of working it as the weather had become cold, none was used in repairing the puddle slopes. The first stone of the foundation course was laid October 22nd, and the paving on the slopes November 8th, was laid up to a height that allowed water to be pumped into the reservoir to a depth of four feet, which was increased as the paving progressed.

The paving was finished November 30th, making thirty-one working days to complete it. The plan of relaying the paving was changed and instead of having a base course laid level with the bottom, a trench was excavated five and one-fourth feet deep and at right angles to the slope.

The bed stones varied from three and one-half to five feet wide, and from twelve to eighteen inches thick, and the second course was about two and one-half feet wide and fifteen inches thick. These courses were laid in cement mortar and at right angles to the slope paving, which was laid dry upon a layer of broken stones from eight to twelve inches thick.

At the foot of the old paving on the west slope which remained in place adjoining the southwest angle a block of cement concrete three feet square and forty-six feet in length was laid to prevent it from sliding. At the foot of the north slope, at the northwest corner a block of granite masonry about three feet square and nine feet in length was laid in cement mortar.

The northeast slope paving which bulged near its center soon after the reservoir was completed has increased some during the past thirteen years, but is considered stable. During the time the basin was drawn off this slope was carefully measured and watched, and no movement was discovered. This paving will probably remain as it is, if a blind drain is laid outside the exterior slope at a depth below the bulged portion so as to intercept and carry off the water from the springs which are in the side hill above. To prevent this slope from sliding, which has started at the foot, a dry wall eight feet wide and four feet high was laid overlapping the footing course. This work was done under a contract with Luther F. Kittredge.

The other slope paving has remained as originally laid except a slight settlement at the top.

I would recommend that the waste material which is now piled up against the west embankment be used in the spring to increase the thickness of the embankment at the base, and also that the portion



opposite the gate house be considerably increased. The top of the entire embankment should be raised on the inner line so as to incline the surface toward the outer slope to prevent any drainage into the reservoir.

Respectfully submitted,

GEORGE E. EVANS, *City Engineer.*

THIRTEENTH ANNUAL REPORT  
OF THE  
Superintendent of Water Works,  
TO THE  
LOWELL WATER BOARD.

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JANUARY 1, 1886.

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## REPORT OF THE SUPERINTENDENT.

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SUPERINTENDENT'S OFFICE, CITY HALL.  
LOWELL, JANUARY 1, 1886.

*To the Lowell Water Board:*

GENTLEMEN:—In compliance with the requirements of the City ordinance relating to the Water Works, I respectfully submit herewith the thirteenth annual report of the Superintendent of the Lowell Water works for the year ending December 31st, 1885.

The total amount of water pumped into the reservoir during the year was 1,299,766,280 gallons, an increase of 194,488,680 gallons over the amount used in 1884. This gives an average daily consumption of about 55 gallons of water for each inhabitant, and includes all the water that is used for manufacturing purposes as well as for domestic use, also for street fountains, extinguishing fires, sprinkling streets, etc. The total quantity of water sold by meter measurement amounts to 316,419,050 gallons, an increase over last year of 34,472,650 gallons.

A general inspection of the filter inlet, gallery and conduit was made May 13th by the Water Board accompanied by the City Engineer.

As there was from 6 to 12 inches of silt all through the bottom of the brick conduit and a thick coating of slime on the sides and top of both the gallery and conduit it was deemed advisable to give both the gallery and conduit a general cleaning, and in order to accomplish this in a thorough manner, a 30 inch blow off was connected to the conduit pipe on the westerly bank of Beaver Brook, and a 30 inch gate set in the main line, so that by closing this gate and opening the blow off gate, the conduit can be drawn off in a short time. July 16th the conduit was drawn off and as large a force of men as could work to advantage were set at work with hoes and rattan brooms to scrape the bottom and scrub the sides. The cleaning was done in the day time, and each night the 30 inch river gate was opened, letting the water rush through so as to carry all the sediment that had been stirred up during the day, out through the blow off

into Beaver Brook. The work of cleaning the conduit occupied four days, and with the exception of the 1067 feet of tunnel which is not bricked, is now as clean as when first built.

In order to prevent further accumulations of any unhealthy organisms in the conduit, I think it would be advisable to line the bottom and sides of the tunnel either with brick or concrete, and by so doing the whole conduit could be cleaned at any time and at a small expense.

#### GALLERY.

As the water in the gallery could not be drawn down less than 18 inches in depth, two steam pumps each having a capacity of raising 1000 gallons per minute, were set at the manhole near the filter inlet. As soon as the gallery was pumped dry, the top and sides were cleaned and washed in the same manner as the conduit, and all the sediment in the bottom scraped up and hoisted out from the manholes and gate chamber.

The water throughout the gallery is now perfectly clear, and the whole place is as clean as when it was first constructed.

#### FILTER INLET.

After cleaning the gallery, the water in the filter inlet was pumped out and carried by wooden spouts into the river. The inlet was then cleaned, fresh sand put in, and a box 12 inches by 24 inches, and 65 feet long, laid from the inlet out into the river to the outside of the old piling. By this arrangement, all the water which now flows into the inlet, comes from the river 65 feet out from the shore, and prevents the silt on the bank from being washed into the inlet.

It is expected that as long as the inlet is perfectly clean, that sufficient water will filter through to supply the gallery with all the water needed; but shortly after this job was completed, there was a rise in the river, so that the water flowed over the front bank into the inlet, leaving so much deposit that no water would filter through. In order to make this inlet available, the bank on the the river side should be raised several feet higher than it now is, so that no ordinary freshet would overflow it, and then with a steam pump to remove the water whenever the inlet needed cleaning: probably filtered water exclusively, could be had for a large portion of each year.

#### PUMPING STATION.

At the Pumping Station the Morris engine has pumped 1,093,451,360 gallons, and the Worthington has pumped 206,314,920 gallons

of water into the reservoir. No repairs of any account have been made on either engine. The No. 1 boiler has had a new set of wrought iron tubes, a 2½ inch return bend coil heater has been put into the flue behind the new boilers, and a sleeping apartment has been partitioned off from the engine room.

#### HIGH SERVICE.

Eighteen million three hundred and ninety-two thousand and thirty-eight gallons of water have been pumped into the high-service reservoir during the year, a decrease of 781,312 gallons over last year. There have been no new extensions laid on this division but 3 services in Belvidere and 2 in Centralville have been added, making a total of 119 houses, 6 stables, 2 fountains, and 30 hydrants now supplied with water from the high service system.

#### RESERVOIRS.

September 26th pumping was suspended preparatory to drawing off the reservoir in order to clean out whatever sediment had accumulated during the past thirteen years. There was an average depth of about 4 inches of sediment, composed principally of silt which had been pumped up from the river during freshets.

While the reservoir was being drawn down, three of the paved slopes slipped out from the bottom, necessitating the entire rebuilding of these slopes.

For a detailed statement of the accident and the repairs of the slopes, I refer you to the accompanying report of the City Engineer Mr. George E. Evans.

Pumping was resumed October 4th, the gate between the gate chamber and reservoir being closed, and the partition gate opened, so that the water went direct from the force main through the gate chamber into the distributing main.

October 5th, the water having all been drawn out of the reservoir, work was commenced preparatory to taking out and relaying the slopes which were completed December 2nd. After the slopes were finished the fences were replaced, but the winter season being so far advanced it was thought best to suspend cleaning up the grounds until spring.

After the sediment had been removed from the reservoir and the remaining slopes scraped and washed, water was again let in, and November 26th the reservoir being so near completed that it held 20 feet of water, the mains throughout the city were given a thorough blowing off, so that now the whole water system is practically as clean as when first constructed.

## EXTENSIONS.

Two miles two hundred and ninety-three feet of mains have been laid this year, mostly on new streets and in many cases where the revenue will doubtless be small for several years, but in each of these cases the petitioners signed a bond agreeing to pay the interest on the cost of the pipe for five years, after deducting 125 feet for every house taking water. The line laid this year through Lincoln street over Hale's brook, gives another feeder to Ayer City, and is liable to be much needed if a large fire should occur in that section.

## HYDRANTS.

There have been 8 post hydrants set on extensions. The flush hydrant at the lower end of Prince street has been taken out, also the two old style hydrants on the 4 inch line back of the City hall. The 3 old style hydrants on Bridge street, and 2 old hydrants on French street have been replaced by new Ludlow hydrants. The flush hydrant boxes throughout the city are beginning to be badly decayed and 12 have been replaced by cast iron ones, while 32 have been replanked.

## METERS.

There are now 1421 meters in use, an increase of 73 over last year.

The following amount of work has been done on meters: Meters set during the year, 88; meters taken out for repairs, 427; meters taken out and others set in their place, 81; Worthington meters taken out cleaned, repaired and reset, 95; Desper meters sent and repaired at Worcester, 245; Desper meters taken out and repaired at shop, 23; meters worn out and replaced by others, 10; meters destroyed by freezing, 19.

Meters Running January 1st, 1886.

Size in inches.	$\frac{1}{2}$ in.	$\frac{3}{4}$ in.	1 in.	1 $\frac{1}{2}$ in.	2 in.	3 in.	4 in.	Motor Register.	Totals.
Desper . . . .	501	134	64	1					700
Worthington . .	290	29	49	70	24	6	2		470
Crown . . . .	57	75	26		2		1		161
Duplex . . . .	17	15	10						42
Ball & Fitts . .	21	9	2	1					33
Fitts Rotary . .	9	1	1						11
Motor Register .								4	4
Total, . . . .	895	263	152	72	26	6	3	4	1421

## SERVICES.

Two hundred and fifty-four new services have been put in ; 133 old services have been changed for either lead or larger iron, and 24 services having been discontinued were cut off at the main.

Complaints regarding the filling up of the service pipes have been of frequent occurrence. Also many of the first services laid have already begun to rust through, showing conclusively that there is a limit to the durability of wrought iron pipe. This year it was thought advisable to substitute lead pipe, in consideration that Prof. Samuel Cabot of Boston had made a careful analysis of our city water, also of lead pipe which had been in use here over 12 years and reported that there could be no trouble caused by the use of it.

The amount of service pipe laid as follows :

Laid during 1885, $\frac{3}{4}$ inch wrought iron pipe.....	1,664 feet
" " 1 inch " " .....	2,579 "
" " $1\frac{1}{2}$ inch " " .....	32 "
" " 2 inch " " .....	243 "
" " $2\frac{1}{2}$ inch " " .....	56 "
" " 3 inch " " .....	20 "
" " $\frac{5}{8}$ inch lead " .....	3,450 "
" " $\frac{3}{4}$ inch " " .....	582 "
" " 1 inch " " .....	345 "
<hr/>	
Total laid during 1885.....	8,971 feet
Add amount previously laid.....	258 320 feet
<hr/>	
Total amount laid.....	267,291 feet



## Number and Kind of Services Changed During the Year Ending Dec. 31, 188

SIZE OF SERVICES CHANGED FOR	$\frac{3}{8}$ in. lead.	$\frac{1}{2}$ in. lead.	1 in. lead.	1 in. iron.	$1\frac{1}{8}$ in. iron.	$1\frac{1}{4}$ in. iron.	2 in. iron.	Total in feet
43 $\frac{3}{4}$ inch. iron.	1838							1838 feet
36 $\frac{3}{4}$ inch. "		1936						1936 "
30 $\frac{3}{4}$ inch. "			1208					1208 "
2 1 inch. "			96					96 "
16 $\frac{3}{4}$ inch. "				537				537 "
1 $\frac{3}{4}$ inch. "					31			31 "
4 $\frac{3}{4}$ inch. "						170		170 "
1 1 inch. "							32	32 "
133 Totals . .	1838	1936	1304	537	31	170	32	5,845 feet

During the year the water has been shut off from the premises of 50 water-takers for non-payment of water rates, and the number upon payment of the rates is 34. The whole number of services remaining shut off for non-payment is 16.

## ITEMS OF OTHER WORK DONE.

A new survey has been made of all the stop gates on the storm drains. This was found necessary, as many of the former stop bounds had been so changed that frequently much difficulty was experienced in finding them, especially when covered with snow. The service boxes, street gates and hydrants have been inspected and put in good order. Large pipe drinking fountains have been set in place of the old style ones at Salem street, corner of Pawtucket street, also on Lawrence street, corner of Agawam street. Two self-closing drinking fountains have been set on the South Common. The following fountains have been taken out and discontinued: Middlesex street, opposite St. Cloud hotel; Middlesex street, opposite A. Wright's market, and at Lincoln street, corner of Tanner street.

The two 12-inch gates on the corporation line on Worthen street and on Tremont street, have been taken out and the three-inch capped, as it was evident that the gates would never be used while they were.

New fences have been built around the pipe yard on Broadway and around the gate chamber grounds on Varnum avenue.

In addition to the cast iron main pipe laid there has been an additional amount of wrought iron smaller sizes as per following :

Schedule of Small Pipe Laid.

STREETS.	1 inch.	1½ inch.	Total ft.
Cabot, changed from ¾ inch . . . . .		129	129
Court off Fulton street . . . . .		190	190
Court off Old Meadow Road . . . . .	166		166
Lowell Manfg Co., off Market St., lead . .	283		283
Meadowcroft (off in court) . . . . .	147		147
Mt. Grove . . . . .		245	245
Old Meadow Road . . . . .		587	587
Old Meadow Road, changed from ¾ inch . .		372	372
West . . . . .	57		57
<b>Total . . . . .</b>	<b>653</b>	<b>1523</b>	<b>2176</b>

In conclusion, I desire to express my sincere thanks to your honorable Board for the uniform kindness extended to me in the discharge of my several duties during the past year.

Respectfully submitted,

HORACE G. HOLDEN, Supt.

## Low Service.—Water Pipes Laid in 1885.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.				
		4 in.	6 in.	8 in.	30 in.	Total.
Arlington .	Extended south'y to Bowers st.	50				50
B . . .	Extended westerly . . .		42			42
Barker Ave. .	Southerly from Sutherland st.		82			82
Barker Ave.	Boynton and Ludlam streets		158½			158½
Bowers .	Extended westerly to Arlington	53				53
Boynton .	Extended westerly . . .	50½	175			225½
Brooks .	Extended easterly to Fletcher		184			184
Court (Ward 5)	Northeasterly from Butler	198½				198½
Cumberland r'd.	Extended southerly . . .		63			63
Cumberland r'd.	Northerly from Ludlam .		303			303
E. Merrimack	Extended easterly to town line		862½			862½
Humphrey .	Northerly from Methuen .		539			539
June . . .	Northerly from Thirteenth .		199			199
Lincoln . .	Across Riv. Meadow Brook to Ayer City, . . . .		540			540
London . .	Easterly from West to connect		209			209
Ludlam . .	Easterly from Hildreth .		727			727
Ludlam . .	Westerly from Barker avenue		157			157
Ludlam . .	Easterly from Barker avenue		159			159
Lundberg .	Extended easterly . . .	96				96
May . . .	Twelfth and Thirteenth .		602½			602½
Meadowcroft	Extended southerly . . .		195			195
Methuen .	Extended Easterly . . .		381			381
Oakland Ave.	Southerly from Pine . . .		446			446
Pine . . .	Extended Westerly . . .		148			148
Second Ave.	Extended northeasterly . .		108			108
Seventh . .	Easterly to Varnum . . .	155				155
South Loring	Extended southerly . . .		375			375

## Low Service.—Water Pipes Laid in 1885.—Concluded.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.				
		4 in.	6 inch	8 inch	30 inch	Total.
Sutherland .	Hildreth st. and Barker ave.		855			855
Taylor . .	Across Concord river .			475½		475½
Third ave. .	N'east'ly from M'moth Road		696½			696½
Twelfth . .	Extended westerly to May		132			132
Walden . .	Westerly from Oakland av.		195			195
Ware . . .	Extended southerly .		47½			47½
Webster . .	Southerly from Tenth .	218				218
West (Ward 3)	Lincoln and London .	205				205
West Fourth .	Extended to pipe in Bridge		144			144
West Nineteenth	Extended easterly .		380			380
Blow-off . .	On pipe c'duit line at B. Bk.				52	52
	Hydrants . . . .		86			86
		1026	9191½	475½	52	10,745
Brooks st. not reported in 1882 . . . .		50				50
West st. Ward 2 " " 1884. . . .			58			58
Total in feet . . . . .		1076	9249½	475½	52	10,853
Low service pipes laid previous to 1885 .						392,408
Total low service to Jan. 1, 1886 .						403,261
High service pipes laid previous to 1885 .						15,171
Total high and low service to Jan. 1, 1886						418,432
Total in miles to Jan. 1, 1886 . . .						79.25

**List of Hydrants Set During the Year 1885.**

STREETS.	LOCATION.
Boynton	Opposite Barker avenue, southerly side
East Merrimack	Southerly side, 38 ft. west from town line.
Humphrey	Easterly side 520 ft. northerly from Methuen street.
Ludlam	Southerly side, 400 ft. easterly from Hildreth street.
May	Westerly side 216 ft. southerly from Thirteenth street.
Methuen	Southerly side, opposite Humphrey street.
Sutherland	Northerly side 412 ft. easterly from Hildreth street.
Third avenue	Northerly side, opposite westerly line Mt. Grove street.
Bridge	Between Merrimack street and Amory street, easterly side. Taken out 3 old pattern P. H., and replaced with 3 new pattern three way P. H.
French	Between John street and Bridge street, taken out 2 old pattern P. H., and replaced with 2 new pattern three way P. H.

## List of Stop Gates Set During the Year Ending Dec. 31. 1885.

STREET.	LOCATION.	4 inch.	6 inch.	12 inch.	30 inch.			
Arlington	2 ft. north of north line Bowers street; 26.8 ft. east of west line Arlington St.	1						
Barker Ave.	On north line of Boynton street; 13 feet west of east line Barker Ave.		1					
Beaver Brook	On pipe conduit line, west side of Beaver Brook.				1			
Brooks	1 ft. west of west line Fletcher street; 14.8 ft. south of north line Brooks St.		1					
Fletcher	On south line Lagrange street; 17.5 ft. west of east line Fletcher street.			1				
Humphrey	On northerly line Methuen street; 13 ft. from east line Humphrey street.		1					
Ludlam	On east line Hildreth street; 15 ft. from south line Ludlam street.		1					
Oakland Ave.	On south line of Pine street; 22.8 ft. west of east line Oakland Ave.		1					
Sutherland.	2 ft. east of east line Hildreth street; 13 ft. south of north line Sutherland St.		1					
Third Ave.	1 ft. N. E. of N. E. line Mammoth Road; 16.5 ft. S. E. of N. W. line Third Ave.		1					
West (Ward 4)	1.5 ft. south of south line Lincoln street; 13 ft. west of east line West street.	1						
W. Fourth	5 ft. w'y from w'y line Bridge street; 15.8 ft. s'y from n'y line W. Fourth street.		1					
Blow off	On pipe conduit line; west side of Beaver Brook.				1			



## Property at Pipe Yard January 1, 1886.

DIAMETER IN INCHES.	4	6	8	10	12	16	20	24	30
Lengths . . . . .	23	17	12	25	122	5	17	8	6½
Sleeves . . . . .		16		1	23	11	4	10	8
Caps . . . . .	1	4	30		16	3	1	3	
Curves . . . . .	13	11	12	2	10	4	10	3	2

DIAMETER IN INCHES.	4x4	6x4	6x6	8x6	8x8	10x6	10x8	12x6	12x8	12x10	12x12	16x6	16x8	16x12
3-Ways . . . . .		2	6	25	5	2		12	7			2	1	
4-Ways . . . . .				2	5	7	1	1	1	1	1			1
Reducers . . . . .	4			6			2	6	4	1				1

**Ston Gates.**—1 4-inch, 5 6-inch, 1 8-inch, 2 12-inch. **Wrought Iron Pipe.**—60 feet 1½-inch pipe, 500 feet 1 inch, 90 feet ¾-inch, 1 reel and 30 ft. ¾-inch lead pipe, 40 ft. ½-inch lead pipe. **20 3-4 Inch Tees.**—50 1-inch, 22 1½-inch, 36 1½x1-inch, 11 2-inch. **Crosses.**—24 ¾-inch, 12 1-inch, 12 1x¾-inch, 20 1½x1-inch. **Couplings.**—200 assorted couplings. **Elbows.**—35 1-inch, 12 ¾x½-inch, 33 1x¾-inch, 25 1½x1-inch. **Bushings.**—100 assorted. **Reducing Couplings.**—60. **Plugs.**—12 ¾-inch, 70 1-inch, 36 1½-inch, 10 2-inch. **Unions.**—20 ¾-inch, 40 1-inch, 40 1½-inch, 24 2-inch. **Solder Nipples.**—75 ¾-inch. **Solder Unions.**—60 ½-inch, 35 1-inch. 80 assorted caps. **Corp. Cocks.**—6 ½-inch, 12 1-inch. **Stop and Waste Cocks.**—10 ½-inch brass, 5 1-inch brass, 6¾-inch brass, 21 1-inch, 3 1½-inch. **Regulation Cocks.**—7 ½-inch, 9 1-inch. **Brass Tees.**—40 ¾-inch, 40 ¾-inch plug, 2 iron hydrant boxes, 2 wood gate boxes, 70 sidewalk boxes, 21 earthen pipe sidewalk boxes, 2 saw horse, 1 buck saw, six hand saws, 1 main pipe testing machine, 2 pipe benches, 3 tool boxes, 3 derricks, 2 fall ropes, 2 sets of blocks, 6 draught chains, 5 wheelbarrows, 2 tongs for cleaning sidewalk boxes, 5 hydrant boxes, 5 frames, 15 covers, 7 gate box frames, 12 covers, 2 set castings for small drinking fountains, ½ cord logs for blasting purposes, 20 picks, 25 pick handles, 12 square shovels, 25 shovels round point, 20 scrub brooms, 6 hand brushes, 24 pairs rubber boots, 10 lanterns, 30 feet rubber hose, 1 hose reel, 2 brass goose neck hydrants, 6 calking sets, 4 nail hammers, 150 sidewalk caps, 200 hundred feet canvass hose, 30 iron lug straps, 250 lbs. bolts, 12 assorted files, 12 assorted gravel screens, 50 lbs. cotton waste, 2 trowells, 10 lbs. iron washers, 30 lbs. assorted nuts, 4 hand hatchets, 1 ax, 5 sling ropes, 1 iron rake, 4 wood plugs for main pipe, 2 tag ropes, 1 dualin pot, 1 10-gallon can, 9 striking hammers, 10 hand hammer handles, 10 striking hammer handles, 1 16-foot straight edge, 350 lbs. pig lead, 3 set old blocks, 2 lead pots, 1 furnace for melting lead, 25 feet drain pipe, 1 zinc pump, 2 copper force pumps, ½ keg 10d nails, ½ keg 30d nails, 40 assorted wrenches, 8 rammers, 3 paving mauls, 6 bbl. cement, ¼ bbl. white clay, 2 snow shovels, 1 work shop, 1 carriage house, 1 stable, 1 store shed, 2 spirit levels. 100 feet lumber for repairing boxes, 2 patterns for making boxes, 1 set blacksmith tools, 800 lbs. steel in drills, 4 scrapers for blasting purposes, 4 lbs. pipe wedges, 3 yarning irons, 2 lead ladles, 8 crow bars, 3 horses, 3 express wagons, 1 light wagon, 3 horse blankets, 3 halters, 2

pungs, 2 horse brushes, 2 hay forks, 2 manure forks, 1 wagon jack, 2 wagon wrenches, 2 canvass covers for horses, 4 harnesses, 2 tons of hay,  $1\frac{1}{2}$  tons of carrots, 600 feet of lumber for gate boxes, 6 post hydrants, 6 flush hydrants, 15 second hand hydrants, 12 pairs pipe tongs, 2 stilson wrenches, 5 monkey wrenches, 3 tapping machines, 20 dippers for drinking fountains, 150 feet block tin wire, 1 30-foot extension ladder,  $\frac{1}{2}$  bbl. linseed oil, 1 gallon paint for fountains, 2 ratchet cutters, 4 pipe cutters, 4 pipe vices, 20 dies, 2 ratchet die plates, 6 die plates,  $1\frac{3}{4}$  inch tap, 1 inch tap,  $1\frac{1}{2}$  inch tap, 4 oil cans, 125 feet block tin tubing, 1 soldering pot, 1 mould, 1 charcoal furnace, 1 naptha furnace, 3 bbl. charcoal, 5 soldering irons, 20 gate spindles, 2 gate disks, 11 hydrant spindles, 24 hydrant valves, 12 hoes, 33 hydrant packings for top, 33 hydrant packings for bottom, 34 5-inch packings for top, 34 5-inch for bottom, 10 packings for 4-inch gate, 12 packings for 6-inch gate, 6 packings for 8-inch gate, 3 packings for 12-inch gate, 1 packing for 16-inch gate, 1 map of distributing main pipes, 1 map showing stop gates, one map of Lowell, 1 map of United States. *Meters.*—1 2-inch. *Worthington Meter.*—3 1-inch, 2  $\frac{5}{8}$ -inch, 1 1-inch. *Desper Meter.*—2  $\frac{3}{4}$  inch, 6  $\frac{5}{8}$  inch, 3 1-inch. *Crown Meter.*—3  $\frac{3}{4}$  inch, 2  $\frac{3}{8}$  inch, 15  $\frac{5}{8}$  inch. *Worthington Meter Second Hand.*—3  $\frac{5}{8}$  inch Ball & Fitts, 3  $\frac{5}{8}$  inch meter, Fitts Rotary meter. *Crown.*—2  $\frac{5}{8}$  inch, 5 bottoms, 8 tops, 15 indicator covers for Worthington meter, 3 lbs. sealing wax,  $\frac{1}{2}$  box crayons,  $\frac{1}{2}$  box wax candles, 3 set packing patterns, 3 lbs. leather, 1 wire brush, 2 oil pans, 1 brass lantern, 1 pair cut nippers, 6 hard packings for meter, 10 valves and valve seats, 1 roll paper packing, 25 spindles for Worthington meter, 8 spindles for Desper, 2 brass lamps, 1 pair pliers, 1 leather tool bag, 2 match safes, 200 brass unions for  $\frac{5}{8}$  inch meters, 25 brass nipples and unions for 1-inch meter, 14 brass nipples and unions for  $1\frac{1}{2}$  inch meters, 4 brass nipples and unions for 2-inch meter, 1 5-gallon can, 2  $\frac{1}{2}$  gallon cans, 2  $\frac{1}{4}$  gallon cans, 1 seive and cover, 1 pail and 2 tanks for testing meters, 1 platform scale, 2 chairs, 1 desk, 1 portable closet, 1 clock, 5 pair pipe tongs, 2 stilson wrenches, 4 monkey wrenches, 4 screw drivers, 1 iron wood mallet, 1 claw hammer, 1 hatchet, 1 foot lathe, 1 lathe dog, 1 broom, 1 brush, 1 coal stove, 1 coal hod, 1 surface plate, 1 bit stock, 2 bits, 1 handsaw, 200 lbs. old brass, 2 rubber connections, 2 10-foot ladders,  $1\frac{1}{2}$  inch top,  $1\frac{3}{4}$  inch, 1 1-inch, 1  $1\frac{1}{2}$  inch, 1 pair snips, 2 washer cutters, 2 soldering irons, 1 2-inch anger, 1 set of numbers, 1 fore plane, 1 bench block, 1 Universal chuck, 1 counter scale, 2 small hammers, 35 out and inlet connections to Desper meter, 6 lead connections for taking out Worthington meter.

### Property and Tools at Engine House.

1 vise, 1 work bench, 1 portable forge, 8 sets brasses for engine, 2 sets differential blocks, 1 piece 2-inch rope, 1 set fire irons, 1 brass hydrant, 3 axes, 11 wrenches, 3 handsaws, 2 jack screws, 12 cold chisels, 2 ratchet drills, 1 socket drill, 3 calking chisels, 1 barometer, 2 thermometers, 1 desk, 2 indicators, 1 oil cupboard, 2 oil dishes, 1 platform scale, 4 crow bars, 64 feet  $\frac{5}{8}$  inch chain, 16 eyebolts, 1 truck, 1 key wrench for air pump, 1 iron wheelbarrow, 1 bucksaw, 1 saw horse, 2 gas lamps, 1 high grade thermometer, 4 brass bolts  $\frac{1}{2}$  inch diameter for pump valves, 5 spare pump valves, five sets spare weights for valves, 11 wrenches for Morris engine, 11 finished wrenches for Worthington engine, 3 sledge hammers, 10 drills assorted sizes, 1 bit stock, 5 bits, 1 25-foot ladder, 1 20-foot, 18-foot, 1 pair steps, 1 hoe, 2 racks, 1 small die plate, 1 fore plane, 6 monkey wrenches, 100 feet 2 inch rope, 4 chisel bars, 6 small taps, 4 finished socket wrenches for Worthington engine, 3 14-quart iron pails, 4 hand hammers, 2 grind stones, 1 anvil, 7 pairs gas tongs, 1 wrench, 11 finished wrenches, 1 clock, 1 set Walworth's solid dies from  $\frac{1}{4}$  inch to 2-inch right and left, 2 die stocks and bushings, 2 sets 2 shive blocks, 3 pieces  $\frac{5}{8}$  inch chain, 1 24-inch elbow for Worthington force main, 1  $2\frac{1}{4}$  ratchet wrench for 30-inch gate river crossing, 1 scythe, 1 snath, 7 chairs, 1 desk, 1 table.



**Tools at Reservoir.**

1 iron tooth rake, 1 hay fork, 3 shovels, 1 ax, 1 piece 1-inch rope, 2 hoes, 1 scythe, 1 snath, 1 grass hook, 8 wheelbarrows, 3 thermometers, 1 snow shovel, 1 stop gate wrench, 1 sidewalk wrench, 1000 feet second hand lumber, 2 spare screens, 20 lbs. nails, 1 coal stove, 1 bracket lamp, 1 lantern, 1 pick, 1 ice chisel.

**Tools at Filter Inlet.**

2 iron tooth rakes, 11 shovels, 1 rammer, 1 ax, 2 ice chisels, 1 stop gate wrench, 1 nail hammer, 1 pick, two brooms, 1 wheelbarrow.

**Property in Water Board and Superintendent's Office.**

12 chairs, 4 high stools, letter press, 7 desks with drawers, 3 standing desks, 2 office tables, 1 bookcase, 1 book rack, 1 bill cabinet, 6 inkstands, 1 clock, 1 glass mug, 3 waste baskets, 3 spittoons, 4 wrenches, 1 pick, 1 map of water distributing pipes, 2 mats, 1 lantern, water gauge, 1 apparatus for gates, 1 screw driver, 1 safe, 1 key rack, 1 atlas of Lowell, 1 black walnut bookcase, 1 instrument for testing capacity of engines.

# SUMMARY OF STATISTICS,

AS SUGGESTED BY THE NEW ENGLAND WATER WORKS ASSOCIATION.

## Lowell Water Works, Lowell, Mass.

Population in 1885, 64,051

Constructed in 1872 ; owned by the City of Lowell.

Source of supply is Merrimack River.

Mode of supply is by pumping and consists of one Morris pump and one Worthington pump, of 5,000,000 gallons capacity each.

The kind of fuel used is Powelton Bituminous coal.

Cost of coal is \$4.17 per ton of 2240 lbs.

	MORRIS PUMP.	WORTHINGTON PUMP.
Total coal consumed . . .	1,961,240 lbs.	480,180 lbs.
Total water pumped . . . .	1,093,415,360 gals	206,314,920 gals.
Average head pumped against .	162.3 ft.	160.76 ft.
No. of gals. pumped per lb. of coal	558 gals.	430 gals.
Duty . . . . .	75,409,571 "	57,564,938 "
Cost of raising per million gals.	\$7.12	\$8.22

## Financial.

RECEIPTS.	EXPENDITURES.
Water rates . . . . \$151,956.79	Construction . . . \$ 15,455.03
Services, meters, etc. . . 6,000.00	Maintenance . . . 47,156.62
Appropriation . . . . 3,000.00	Meters . . . . . 1,418.59
Loan . . . . . 15,000.00	Interest . . . . . 111,850.00
Total . . . . . \$175,956.79	\$175,880.24

## SUMMARY OF STATISTICS.

## CONSUMPTION.

Total number of gallons consumed for the year.....	1,299,766,280
Average daily consumption.....	3,561,000
Gallons per inhabitant.....	55.

## DISTRIBUTION.

Cast iron pipe is used from 4 inches to 30 inches diameter :

Extended in 1885.....	10,853 ft.
Total in use.....	79.25 miles.
Hydrants in use.....	760
Stop gates.....	552
Blow offs.....	13
Greatest pressure .....	70 lbs.
Number of services in use.....	6913
Number of meters in use.....	1421

**Analyses of Lowell City Water, made by S. Cabot, Chemist, July 10th, 1885.**

**WATERS.**

		AMMONIA.		NITROGEN AS		
		Free.	Alb'd.	Chlorine.	Nitrates.	Solids.
Lowell City						
Water,	. C.	0.03	0.13	4.107	2.0617	2.740
Gallery,	. . G.	0.14	0.105	4.107	Traces.	3.615
River,	. . R.	0.05	0.14	3.422	Traces.	3.324
Cochituate,	.	0.027	0.27	6.844	0.0741	7.581
Parts per million.				Grains per gal.		

**SEDIMENTS.**

		AMMONIA.		Total Solids.	Volatile Matter.
		Free.	Alb'd.		
Conduit Bottom,	. C. B.	17.32	119.50	65.95	4.266
Conduit Sides,	. C. S.	92.00	177.50	17.10	0.296
River Mud,	. . R. M.	33.33	165.50	57.29	1.787
Gallery Sides,	. G. S.	12.00	137.50	6.32	1.081
Gallery Bottom,	. G. B.	6.66	15.50	3.84	0.258
Parts per million.				Parts per hundred.	

**SAME CALCULATED ON MILLION PARTS SOLIDS.**

		AMMONIA.	
		Free.	Alb'd.
Conduit Bottom,	. . C. B.	26.26	181.19
Conduit Sides,	. . C. S.	538.01	1038.01
River Mud,	. . R. M.	58.17	288.88
Gallery Sides,	. . G. S.	189.87	2174.63
Gallery Bottom,	. . G. B.	178.44	403.64



7.58  
FOURTEENTH  
ANNUAL REPORT  
OF THE  
Lowell Water Board

TO THE  
CITY COUNCIL,  
ACCOMPANIED BY THE REPORTS OF THE CITY ENGINEER  
AND OF THE SUPERINTENDENT OF WATER WORKS,  
TO THE WATER BOARD.

JANUARY 10th, 1887.



LOWELL, MASS.:  
CITIZEN NEWSPAPER CO., PRINTERS.  
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141.50

**CITY OF LOWELL.**

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**IN WATER BOARD, January 10th, 1887.**

**Read and accepted and ordered to be transmitted to the City Council.**

**Attest:                      ANDREW J. DEVOLL, *Clerk.***

---

**IN BOARD OF ALDERMEN, January 17th, 1887.**

**Read and ordered on file. Sent down.**

**DAVID W. O'BRIEN, *City Clerk.***

---

**IN COMMON COUNCIL, January 17th, 1887.**

**Received, read, and ordered on file in concurrence.**

**DAVID CHASE, *Clerk.***

# CIVIL ORGANIZATION, LOWELL WATER WORKS.

. From their commencement to Jan. 1, 1887.

## JOINT SPECIAL COMMITTEES.

1869.

Jonathan P. Folsom, mayor.  
Charles A. Stott, alderman.  
Cyrus H. Latham, alderman.  
William H. Anderson, councilman.  
Frederick T. Greenhalge, councilman.  
Albert A. Haggett, councilman.  
Edwin Lamson, councilman.

1871.

Edward P. Sherman, mayor.  
Albert A. Haggett, alderman.  
Henry P. Perkins, councilman.  
Jeremiah Crowley, councilman.  
William Dobblins, councilman.

1870.

Jonathan P. Folsom, mayor.  
Charles A. Stott, alderman.  
Albert A. Haggett, councilman.  
Wm. Kittredge, councilman.  
Wm. O. Flake, councilman.

1872.

Josiah G. Peabody, mayor.  
Alexander G. Cumnock, alderman.  
Henry P. Perkins, councilman.  
Nathaniel C. Sanborn, councilman.  
Crawford Burnham, councilman.

## WATER COMMISSIONERS.

1870-'71-'72.

Levi Sprague, chairman.  
Wm. E. Livingston.  
Henry H. Wilder, resigned Sept. 26, 1871.  
Samuel K. Hutchinson, elected to fill vacancy.

## WATER BOARD.

1873.

Levi Sprague, president, from the citizens.  
William F. Salmon, from the citizens.  
Jonathan P. Folsom, alderman.  
Nathaniel C. Sanborn, councilman.  
Nathan W. Frye, councilman.

1878.

Albert A. Haggett, pres., from the citizens.  
James W. Bennett, from the citizens.  
Horace R. Barker, alderman.  
John F. Kimball, councilman.  
Charles H. Harvey, councilman.

1874.

Levi Sprague, president, from the citizens.  
William F. Salmon, from the citizens.  
Nathaniel C. Sanborn, alderman.  
Nathan W. Frye, councilman.  
G. W. S. Hurd, councilman.

1879.

Albert A. Haggett, pres., from the citizens.  
James W. Bennett, from the citizens.  
Horace R. Barker, alderman.  
Edward B. Pierce, councilman.  
Robert G. Bartlett, councilman.

1875.

Geo. Runels, president, from the citizens, resigned Nov. 9, 1875.  
Cyrus H. Latham, president *pro tem.*: from the citizens.  
Benjamin Walker, alderman.  
Albert A. Haggett, councilman.  
Earl A. Thissell, councilman.

1880.

Albert A. Haggett, pres., from the citizens.  
James W. Bennett, from the citizens.  
Robert Wood, alderman.  
Charles C. Hutchinson, councilman.  
Edward B. Pierce, councilman.

1876.

Cyrus W. Latham, pres., from the citizens.  
Earl A. Thissell, from the citizens.  
Albert A. Haggett, alderman.  
Benj. C. Dean, councilman, resigned May, 1876.  
John F. Kimball, councilman, elected to fill vacancy.  
Orford E. Blood, councilman.

1881.

Albert A. Haggett, pres., from the citizens.  
James W. Bennett, from the citizens.  
Robert Wood, alderman.  
Charles C. Hutchinson, councilman.  
Samuel Hosmer, councilman.

1877.

Cyrus H. Latham, pres., from the citizens.  
Albert A. Haggett, from the citizens.  
Horace R. Barker, alderman.  
John F. Kimball, councilman.  
James W. Bennett, councilman.

1882.

Albert A. Haggett, pres., from the citizens.  
Charles C. Hutchinson, from the citizens.  
Thomas R. Garity, alderman.  
William N. Osgood, councilman.  
Frank Wood, councilman.

## WATER BOARD.

1883.

Albert A. Haggett, pres., from the citizens.  
 Charles C. Hutchinson, from the citizens.  
 George W. Fifield, alderman.  
 Edward B. Pierce, councilman.  
 John J. Hogan, councilman.

1884.

Albert A. Haggett, pres., from the citizens.  
 C. A. R. Dimon, from the citizens.  
 George W. Fifield, alderman.  
 Edward B. Pierce, councilman.  
 John J. Hogan, councilman.

1885.

Albert A. Haggett, pres., from the citizens.  
 C. A. R. Dimon, from the citizens.  
 James Francis, alderman.  
 Alfred M. Chadwick, councilman.  
 Arnold S. Welch, councilman.

1886.

Walter Coburn, pres., from the citizens.  
 C. A. R. Dimon, from the citizens.  
 James Francis, alderman.  
 Arnold S. Welch, councilman.  
 Frank S. Howe, councilman.

1887.

Walter Coburn, pres., from the citizens.  
 C. A. R. Dimon, from the citizens.  
 James Francis, alderman.  
 Arnold S. Welch, councilman.  
 Frank W. Howe, councilman.

*Investigations were made at various times, by order of the City Council for the introduction of pure water into the city, viz.: By Joint Special Committee consisting of the following named citizens :*

1838.

Oliver M. Whipple, alderman.  
George Brownell, alderman.  
Thomas Hopkinson, councilman.  
Benjamin Walker, councilman.  
David Dana, councilman.

1839.

Oliver M. Whipple, alderman.  
John Clark, alderman.  
Thomas Hopkinson, councilman.  
Benjamin Walker, councilman.  
John Nesmith, councilman,

1848.

Jefferson Bancroft, mayor.  
Oliver M. Whipple, alderman.  
David Dana, alderman.  
John Avery, councilman.  
Otis L. Allen, councilman.  
Thomas Hopkinson, councilman.  
Ignatius Tyler, councilman.

1865.

George W. Norris, alderman.  
Edward F. Watson, alderman.  
Charles W. Dodge, councilman.  
T. L. P. Lamson, councilman  
John Pearson, councilman.

1866.

Josiah G. Abbott, mayor.  
Charles W. Dodge, alderman.  
Joseph L. Sargent, alderman.  
Benjamin Walker, councilman.  
Edward C. Rice, councilman.

## WATER BOARD, 1887.

*President* . . . . . WALTER COBURN.

Term expires first Monday in May, 1887.

C. A. R. DIMON,

Term expires first Monday in May, 1888.

ALDERMAN JAMES FRANCIS.

Councilman ARNOLD S. WELCH.

Councilman FRANK W. HOWE.

*Clerk* . . . . . ANDREW J. DEVOLL.

*Superintendent of Works* . . . . . HORACE G. HOLDEN.

*Foreman of Works* . . . . . THOMAS DOYLE.

*Engineer at Pumping Station* . . . . . JAMES P. ROBERTS.

*Service Clerk* . . . . . LEONARD T. FARRIS.

*Inspectors.*

JOHN J. BANCROFT.


THOMAS E. LENNON.

WILLARD S. KNOWLTON.

HENRY E. SPRAGUE.

*Meter Inspector.*

ROBERT GARDNER.

 The Water office is open daily, from 9 A. M. to 3 P. M., and on Monday evenings, from 7 to 8 o'clock.

## REPORT OF THE WATER BOARD.

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OFFICE OF THE LOWELL WATER BOARD,  
LOWELL, MASS., JAN. 10, 1887.

*To the City Council of the City of Lowell:*

GENTLEMEN—The Lowell Water Board in accordance with the Ordinances of the City of Lowell herewith presents the Fourteenth Annual Report of the Board:

The year 1886, like its predecessor, shows a continued increase in net charges for water used, and the Department has reached a point where it is self-sustaining. The increase over the preceding year is \$9,903.43, leaving us a balance of \$4000 over all expenses. The dwelling houses of the Engineer and of the man in charge at the Beacon Street Reservoir have been put in thorough repair at a cost of some \$800, and the expense charged to maintenance. The Works are as nearly completed as they ever will be, as extensions and improvements will be necessary every year, to a certain extent.

The Department in all its branches is in excellent condition.

For details of the workings of the Department, we would refer you to the Report of the Superintendent and Report of the Engineer accompanying.

The first meeting of the Board for 1886, was held January 25th.

The Board, consisting of the following members, Walter Coburn, President, and Col. C. A. R. Dimon from the citizens, and Alderman James Francis and Councilmen Arnold S. Welch and Frank W. Howe, from the City Government.

#### ORGANIZATION.

The Annual Organization under the City Ordinances occurred May 3d. The Board was composed of the same members as above—Col. C. A. R. Dimon having been re-elected as a member of the Board from the Citizens. The Board organized by the choice of Walter Coburn as President, and A. J. Devoll as Clerk.

#### CONTRACTS.

February 3d a contract was made with the Mellert Foundry and Machine Company, of Reading, Pa., for one hundred and fifteen tons of pipe and specials amounting to \$3,209.50. July 17th a contract was made with Wm. E. Livingston for one thousand tons of Maryland Co.'s Cumberland Coal, at \$4.65, delivered.

#### STATISTICS.

The total amount of water pumped during the year was 1,441,622,640 U. S. gallons, an increase over the year 1885 of 141,856,360 U. S. gallons. The daily average was 3,949,738 U. S. gallons pumped into the Low Service, and 55,487 U. S. gallons pumped into the High Service Reservoir,

an increased daily average over the year 1885, in the Low Service, of 338,834 U. S. gallons.

1392~~1111~~ tons of coal have been used during the year, 31 1-2 tons of which were used for the High Service engine; 245 tons for the Worthington engine; 1,107 1-4 tons for the Morris engine.

There have been 321~~170~~ gallons of water raised 164 feet high for each pound of coal consumed by the High Service engine, 432~~70~~ gallons raised 164 feet high for each pound of coal consumed by the Worthington engine, and 551~~80~~ gallons raised 164 feet high for each pound of coal consumed by the Morris engine. These remarkable results show the perfect condition in which the property of the city is kept at the Pumping Station.

The result of the year's work at the Pumping Station is gratifying to the Board, and to every citizen interested in the Department. The cost of pumping 1,000,000 gallons has been reduced from \$7.12 in 1885, to \$6.52 in 1886, by the Morris engine, and from \$8.22 in 1885, to \$7.53 in 1886, by the Worthington engine.

This is the lowest cost ever reached by this Department, and our Engineer, Mr. James P. Roberts, may feel a justifiable pride in the results attained.

The total net charges for water-rates for the year, after deducting all abatements and charges for service pipes, have been \$163,651.75, against \$153,748.32 for the year 1885, an increase for the year of \$9,903.43. Total number of water-takers, 14,710.

The following table will show the monthly charges for water from the commencement of the Works to Dec. 31, 1886, with all abatements and total net charges:



**Charges for Water by Months, from Commencement to December 31, 1886.**

MONTHS.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.
January.		\$ 363 94	\$ 418 96	\$ 150 45	\$ 136 51	\$ 169 14	\$ 282 44	\$ 233 73	\$ 182 58	\$ 233 37	\$ 271 52	\$ 472 76	\$ 702 03	\$ 410 21
February.	.....	35 53	235 43	238 85	86 84	144 38	298 19	349 08	146 40	139 22	136 06	347 65	332 90	459 68
March.	\$6,124 94	50,200 10	65,417 68	82,249 51	89,177 52	82,225 43	80,003 69	80,507 44	89,210 88	90,830 37	94,356 65	98,692 13	102,661 30	104,537 77
April.	785 89	1,739 50	635 20	265 34	584 11	1,970 12	9,242 84	6,478 39	540 20	403 64	293 10	351 73	439 64	1,355 01
May.	2,988 16	3,274 00	2,147 96	874 47	1,819 65	1,121 43	2,751 35	1,476 15	879 61	1,191 41	984 84	1,495 90	1,082 34	1,700 48
June.	5,818 78	2,805 86	2,887 43	4,460 91	2,389 52	3,903 69	6,196 86	868 08	12,574 12	16,401 62	17,757 44	18,760 27	21,203 61	23,708 43
July.	4,833 52	1,889 03	1,926 31	582 68	3,147 78	1,261 24	1,213 13	11,457 84	273 00	959 80	1,059 37	860 21	1,053 36	1,434 99
August.	2,738 30	408 50	449 86	771 87	799 88	677 01	563 35	459 17	514 46	634 40	902 76	984 17	828 40	1,173 44
September.	2,827 07	3,245 06	805 90	495 97	3,403 90	4,908 07	6,384 86	8,108 23	10,088 19	10,904 30	12,467 32	12,639 94	13,452 97	16,105 05
October.	9,729 05	872 10	2,947 93	4,893 44	543 79	683 80	454 29	338 51	369 22	552 27	941 81	738 12	697 87	783 29
November.	761 21	634 03	573 35	1,445 65	518 72	1,220 27	1,405 89	620 56	873 16	378 97	1,615 65	693 41	477 10	686 02
December.	1,571 72	3,689 79	3,953 59	3,246 39	4,040 71	4,522 75	5,794 77	7,851 52	9,593 32	10,848 68	12,512 70	12,544 55	12,617 45	12,825 41
Totals.	\$39,108 64	\$69,307 39	\$82,861 60	\$99,574 93	\$98,178 50	\$102,877 32	\$115,261 20	\$118,808 70	\$125,975 27	\$133,503 45	\$143,869 22	\$148,928 85	\$155,848 98	\$165,279 78
Less abate- ments to date	.....	1,872 83	640 06	8,185 88	2,502 65	4,343 13	9,590 05	1,702 13	3,766 88	2,490 50	3,694 15	4,314 79	2,100 66	1,628 03
Net amounts	\$39,168 16	\$67,434 56	\$82,221 54	\$91,489 05	\$95,676 28	\$98,534 19	\$105,671 15	\$117,106 58	\$122,208 39	\$131,012 95	\$140,775 07	\$144,614 06	\$153,748 32	\$163,651 75

## FINANCIAL STATEMENT.

The total gross amount of bills sent to the City Treasurer for collection for this Department during the year ending Dec. 31, 1886, is as follows, viz:

For Water Rates.....	\$96,539.37	
Metered water.....	68,740.41	
<hr/>		
Total for the use of water.....		\$165,279.78
For service pipe and laying.....	\$1,718.48	
Meters sold.....	1,936.00	
Sundry accounts.....	4,841.44	8,495.92
<hr/>		
Total charges for the year.....		\$173,775.70

The following statement exhibits receipts and expenditures for the year, the net cost of the Water Works, including the interest on the Water Loan, and all expenses in excess of receipts for water rates; also the total cost and expenses of the Works by taxation:

Net cost of Water Works to Jan. 1, 1886, as per last annual report.....	\$2,388,217.82
Expended during the year for Water pipes, and for laying the same, and all other items of	

## CONSTRUCTION.

MATERIALS FOR MAINS, SERVICES, &C.:—		
Cast-iron pipe.....	\$5,676.48	
Cast-iron specials.....	305.06	
Wrought-iron pipe and fittings.....	200.23	
Iron castings.....	278.47	
Brass castings.....	15.22	
Lead pipe.....	1,257.00	
Lead pig.....	428.72	
Powder, fuse, &c.....	34.60	
Stop and waste cocks.....	551.00	
Hardware.....	60.99	
Teaming pipe.....	121.14	
Freight.....	371.16	
Tin pig.....	27.50	
Repairing tapping machine.....	26.00	
<hr/>		
Amounts carried forward,	\$9,353.57	\$2,388,217.82

<i>Amounts brought forward,</i>	\$9,353.57	\$2,388,217.82
Drinking fountain.....	125.00	
Sundries .....	15.00	
Brass fittings.....	39.86	
Wood and coke.....	22.00	
Concrete.....	7.91	
Service boxes.....	633.59	
Water gates.....	45.39	
Hydrants.....	680.40	\$10,922.72
Cr. by cast-iron pipe sold to town of Rockland.....		504 26
		<hr/> \$10,418.46

## LABOR, PAY-ROLL ON ACCT. OF —

Extensions.....	\$2,105.97	
Services.....	923.33	
Piping.....	813.02	
Foreman.....	914 77	\$4,757.09
		<hr/> \$15,175.55

## MAINTENANCE.

Expended for repairs, current expenses, pumping, &c., viz:—

## REPAIRS.

Iron, steel, &c.....	\$ 105 82
Iron castings.....	101.64
Tools, purchased and repaired.....	31.49
Hardware.....	62.88
Lumber.....	112.27
Carpenter work .....	219 87
Teaming.....	34.50
Boat and oars .....	18.05
Concrete .....	90.25
Brick.....	17.72
Sundries.....	140.86
Labor pay-roll.....	4,334.86
Making and repairing screens.....	33.70
Packing hydrants.....	30.00
Service boxes.....	418.31
Wrought-iron pipe and fittings.....	65 00
Lead pipe.....	700.95
Stop and waste cocks.....	400.82
Hydrant repairs.....	8.10
Sand .....	10.00
Repairs on chimney and lightning rod.....	228.91

*Amounts carried forward,*

\$7,166.00 \$2,388,217.82

# REPORT OF THE WATER BOARD.

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<i>Amounts brought forward,</i>	\$7,166.00	\$2,388,217.82
Repairs of Pumping Station.....	1,866.93	
of Engineer's house.....	410 00	
on trusses under Concord River Bridge.....	101.00	
	<hr/>	
Total repairs.....	\$9,543.93	

## CURRENT EXPENSES. Pay-roll.

Labor .....	\$ 48.75	
Salaries.....	1 900.00	
Inspection.....	3 160.32	
Clerk hire.....	3,264.47	
City Engineer.....	406.00	
	<hr/>	
	\$8,779.54	

## Materials.

Difference in exchange of horse.....	100.00
Printing, stationery, &c.....	519.42
Postage stamps.....	49.10
Travel and express .....	39.50
Sundries office.....	47.70
Telephone .....	214.12
Exchange in sleighs .....	50 00
Coal for yard .....	6.75
Corn, oats, straw, &c.....	186.52
Gas .....	2 18
Sundries, pipe yard.....	14 99
Horse shoeing.....	73.55
Repairing wagons.....	80.22
Repairing harnesses.....	26.15
Labor at pipe yard.....	715.50
Repair of office.....	356.61
Office furniture.....	273.94
Rent of water office.....	75.00
Exchange of carriage.....	95.50

Total current expenses.....\$11,706.29

## PUMPING ACCOUNT.

Coal .....	\$4,924.76
Labor pay-roll.....	3,946.81
Iron, steel, &c.....	25.39
Oil.....	93.72
Gas .....	124.34
Wood .....	30.94
Freight.....	63
Files .....	11.01

*Amounts carried forward,* \$9,157.60 \$2,388,217.82

<i>Amounts brought forward,</i>	\$9,157.60	\$2,388,217.82
Lumber .....	105.31	
Sundries .....	73.01	
Hardware .....	37.41	
Concrete .....	44.95	
Printing, stationery, &c. ....	12.00	

Total pumping account.....	\$9,430.28	
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## METER ACCOUNT.

Meters purchased.....		\$1,379.50
Labor pay-roll.....	\$1,889.54	
Repairs on meters .....	387.40	
Freight.....	13.67	
Supplies.....	49.15	
Unions .....	38.25	
Testing meters.....	19.13	
Tools for repairs of meters.....	270.59	2,667.73
Total meter account.....		\$4,047.23

## RESERVOIR, BEACON STREET.

Manure.....	\$ 24.00
Sundries.....	1.40
Cutting and storing hay.....	98.75
Teaming .....	192.88
Labor, pay-roll.....	694.82
Drs. Gilman and Parker's services .....	164.00
Grass seed.....	7.17
Use of land for draining reservoir.....	100.00
Gravel .....	24.50
Drain pipe and cement.....	190.71
Repairs on reservoir house.....	407.01

Total Reservoir account.....	\$1,905.24
------------------------------	------------

## RECAPITULATION.

Total construction account.....	\$15,175.55
“ repairs.....	\$ 9,543.93
“ Current expenses.....	11,706.29
“ Pumping .....	9,430.28
“ Meter.....	2,667.73
“ Reservoir (Bacon Street).....	1,905.24
Total maintenance account.....	\$35,253.47
Meters purchased.....	1,379.50

<i>Amount carried forward;</i>	\$2,388,217.82
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# REPORT OF THE WATER BOARD.

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<i>Amount brought forward.</i>		\$2,388,217.82
<b>Amount expended for the year exclusive of interest..</b>	\$ 51,808.52	
<b>Interest paid during the year.....</b>	115,535.00	
		<hr/>
		\$167,343.52
		<hr/>
<b>Total expenditures for the year.....</b>		\$2,555,561.34

## CREDITS.

<b>Amounts received by the City Treasurer during the year for water rates, service pipes and sundries, viz:</b>		
For account of 1885.....	\$ 15,421.71	
“ “ 1886.....	153,335.82	
		<hr/>
<b>Total receipts for the year.....</b>		\$168,757.53
		<hr/>
<b>Net cost of works, including interest on Water Loan to Jan. 1, 1887.....</b>		\$2,386,803.81
<b>Present debt of the city, by bonds and notes, on account of construction of Water Works..</b>		\$1,837,000.00
		<hr/>
<b>Total amount paid from the City Treasury to Jan. 1, 1887, by taxation on account of Water Works, in excess of receipts from Loans and water rates.....</b>		\$549,803.81
<b>Value of Water Works Sinking Fund, Jan. 1, 1887.</b>		517,994.42
		<hr/>
		\$1,067,798.23
		<hr/>
<b>Net cost of Works, including interest on Water Loan to Jan. 1, 1887.....</b>		\$2,386,803.81
<b>Whole amount paid by taxation, and by appropriation for the Sinking Funds, and the value of the accumulation of said Funds, Jan. 1, 1887.....</b>		\$1,067,798.23
		<hr/>
<b>Debt of the city on account of Water Works, in excess of Water Works Sinking Funds, Jan. 1, 1887.....</b>		\$1,319,005.58
		<hr/>

The following table will show the gross cost of the Water Works, yearly, from the commencement of the same to Jan. 1st, 1887 :

Expended in 1870	\$ 95,057.00
" 1871	624,151.66
" 1872	560,708.40
" 1873	349,717.87
" 1874	233,370.63
" 1875	275,660.78
" 1876	221,502.24
" 1877	163,814.28
" 1878	158,510.15
" 1879	150,047.82
" 1880	154,391.59
" 1881	231,171.27
" 1882	173,645.92
" 1883	179,713.23
" 1884	174,552.71
" 1885	175,880.24
" 1886	167,343.52
<hr/>	
Gross cost of Works to Jan. 1, 1887.....	\$4,089,239.31
Receipts from various sources to Jan. 1, 1887.....	1,702,435.50
<hr/>	
Net cost of Works to Jan. 1, 1887.....	\$2,386,803.81

# REPORT OF THE WATER BOARD.

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The following table will show the expenditures and receipts of the Works from 1873 to 1887, exclusive of the interest on the Water Debt;

	Expenditures.	Receipts.	Expenditures in excess of receipts.	Receipts in excess of expenditures.
1873	\$188,376.59	\$ 57,739.48	\$130,637.11	
1874	128,108.63	80,625.66	47,479.98	
1875	170,095.78	94,908.14	75,187.64	
1876	115,012.24	98,815.54	16,196.70	
1877	53,988.72	100,825.63		\$46,837.91
1878	49,900.15	104,142.87		54,242.72
1879	42,157.82	110,185.84		68,027.52
1880	45,031.59	123,740.49		78,708.90
*1881	121,601.27	128,053.97		6,452.70
†1882	64,525.92	140,397.96		75,872.04
1883	65,673.23	152,582.99		86,909.76
1884	64,982.71	154,437.55		89,454.84
‡1885	64,030.24	157,956.79		93,926.55
1886	51,808.52	168,757.53		116,949.01

\*In 1881 there were expended the following extraordinary amounts:

For river crossing, 24-inch reserve line.....\$ 9,988.59

For high service water supply..... 57,969.39

†In 1882, high service water supply..... 10,898.59

‡In 1885, Beacon street reservoir..... 14,766.27

Had these extraordinary expenses not occurred, the excess of receipts over expenditures for those years would have been respectively \$74,410.68, \$86,770.63 and \$108,692.82.



This Department received an appropriation of \$3000 for 1886, which sum covered the amount to be paid yearly on the temporary loan of \$15,000, levied in 1885, for repairing the paving of the Beacon Street Reservoir.

Superintendent Holden's length of service and the excellent condition in which streets and sidewalks are left, after being torn up by putting in new, or renewing old service pipe and repairing mains, attest his attention to duty, and the value of his knowledge and experience as an officer of the department and a servant of the city.

Mr. A. J. Devoll, the Clerk of the Board, has attended to his duties in a thoroughly satisfactory manner, not only to the Board but to all who have had occasion to do business with the office; the books of the Department are well kept, and collections closer than for several years past.

The force of Inspectors has been increased by one man, whose especial duty it is to detect leaks and undue waste. The result, after a short experimental trial, has more than realized the expectations of the members of the Board who proposed the addition.

Clerks and assistants in the office have been employed from time to time as the service requires, without regard to political results or criticism.

During the year a machine shop has been built at the Pumping Station, and placed under the supervision of Mr. Roberts, for the repair of meters. It has been satisfactory in its workings and has saved considerable expense to all whose meters have needed repairs.

The Ordinance licensing Plumbers and Pipe Fitters, has not proved as great a success as the Board of 1885

had anticipated. For the City to receive the full benefits of the Ordinance, there should be appointed an Inspector of Plumbing and Piping, to enforce its provisions.

Respectfully submitted,

WALTER COBURN,  
CHAS. A. R. DIMON,  
JAMES FRANCIS,  
ARNOLD S. WELCH,  
FRANK W. HOWE,

*Members of the Lowell Water Board.*

IN WATER BOARD, Jan. 10, 1887.

Read and accepted, and ordered to be transmitted to the City Council.

Attest:

ANDREW J. DEVOLL,  
*Clerk.*

Dr.			Cr.			
1886.			1886.			
			By payments during the year, viz :			
			Interest.	Salaries.	Drafts.	Refunds.
Jan.	Water receipts	\$ 7,250.49	\$ 3,120.00	\$158.33	\$2,826.17	
Feb.	" "	5,499.26	120.00	158.34	1,665.89	
Mar.	" "	2,688.26	360.00	158.33	5,074.09	
Mar.	Appropriation	3,000.00				
Apr.	Water receipts	7,756.35	1,655.00	158.33	4,207.34	
May	" "	50,199.10	20,560.00	158.34	4,987.67	
June	" "	29,252.87	31,422.50	158.33	3,694.48	\$1,244.17
July	" "	15,792.81	1,770.00	158.33	4,574.89	9.88
Aug.	" "	11,805.85	390.00	158.34	2,996.47	
Sept.	" "	7,006.09	300 00	158.33	5,913.41	
Oct.	" "	15,180.39	1,955.00	158.33	6,407.19	6.50
Nov.	" "	11,386.02	20,710.00	158.34	4,704.23	
Dec.	" "	6,180.56	33,172.50	158.33	3,357.84	
			\$115,535.00	\$1,900.00	\$50,409.67	\$1,260.55
			<div style="text-align: right;"> \$169,105.22  Balance . . . 3,892.83  \$172,998.05 </div>			
<div style="text-align: right;"> \$172,998.05. </div>						

**FOURTEENTH ANNUAL REPORT**  
**OF THE**  
**City Engineer to the Water Board.**  

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**JANUARY 1, 1887.**



## REPORT OF THE ENGINEER.

OFFICE OF THE CITY ENGINEER,  
LOWELL, MASS., Jan. 1, 1887.

*To the Lowell Water Board:*

GENTLEMEN:—The undersigned respectfully submits the Fourteenth Annual Report of the work done by the pumping engines at the Pumping Station, and the records as taken at the Beacon Street Reservoir.

The calculations of the duty of the engines were made from the records kept by Mr. James P. Roberts, the engineer in charge.

All the coal used at the Station has been charged to pumping, including what is used for running the small stationary engine, which drives the machinery in the new shop.

In the calculation of the duty nothing has been deducted for ashes or heating the building, and nothing added to the head for friction in the pumps.

The largest quantity pumped during any run of twenty-four hours, is as follows: Morris Engine, December 10th, 6,045,440 gallons, and the Worthington Engine, October 14th, 6,631,830 gallons. The Worthington High Service Engine pumped January 26th, in fifteen hours, 572,264 gallons.

In the table of the running expenses of the engines the amounts will not agree with the pumping account as given in the report of the Water Board, for the reason that only the articles used during the year are included. In making up the cost of running expenses the pay of the men is divided proportionally to the number of hours run by each engine (Morris 84 per cent. and Worthington 16 per cent.).

The cost of repairs on boilers, sundries, tools and stock is divided proportionally to the quantity of water pumped by each engine (Morris Engine 86 per cent., Worthington Engine 14 per cent.).

The average cost of pumping one million gallons from the Beacon Street Reservoir to the High-Service Reservoir, is eight dollars and eighty-five cents, which added to the cost of raising the same quantity into the Low-Service Reservoir, makes the total cost of raising one million gallons into the High-Service Reservoir fifteen dollars and thirty-seven cents.



Table Showing Work Done with Morris Engine (Beam and Fly Wheel) and Boilers for each Month During the Year 1886.

MONTHS.	No. of days Pump- ing.	Ave No. of hours Pumping per day.	Number of hours Pumping per month.	Number of Strokes made per month.	Average No. of Strokes made per minute.	Average head includ- ing friction in feet.	Quantity Pumped per month in U. S. Gallons.	Average quantity pumped per day in U. S. gallons.	No. gal. of water raised in reservoir only, no deduction for total coal consumed.	Duty in lbs., 1 foot high, with 100 lbs. coal, used in pump- ing only, no de- duction for ashes or clinkers.	Duty on total coal consumed,
January . . . .	26	19-41	511-40	387,325	12.62	163.85	123,944,000	4,767,077	559.	91,362,333	76,289,719
February . . . .	21	21-25	449-50	336,691	12.47	164.14	107,741,120	5,130,529	561.	92,635,875	76,762,342
March . . . .	27	17-29	471-55	352,575	12.45	165.88	112,824,000	4,178,667	551.	90,734,638	76,195,825
April . . . .	26	16-29	428-45	323,746	12.58	163.50	103,598,720	3,984,566	555.	90,432,151	75,691,470
May . . . .	16	14-51	237-30	175,703	12.33	163.48	56,224,960	3,514,060	562.	92,293,083	76,526,725
June . . . .	26	18-20	476-30	357,967	12.52	163.86	114,549,440	4,405,748	554.	89,850,537	75,606,470
July . . . .	22	18-48	413-45	309,866	12.48	163.72	99,157,120	4,507,142	543.	87,710,966	74,072,919
August . . . .	27	18-28	498-30	375,675	12.56	164.02	120,216,000	4,452,444	531.	85,587,698	72,519,143
September . . . .	26	17-52	464-30	348,871	12.52	163.71	111,638,720	4,293,797	537.	86,616,604	73,281,359
October . . . .	17	16-15	276-15	209,841	12.66	163.72	67,149,120	3,949,948	564.	91,712,804	76,927,871
November . . . .	22	12-40	278-30	207,898	12.44	165.19	66,527,360	3,023,971	554.	92,326,399	76,323,171
December . . . .	27	21-01	567-20	433,061	12.72	163.91	138,579,520	5,132,575	563.	91,406,686	76,858,820
Totals and Averages.	283	17-56	5075-00	3819,219	12.54	164.08	1,222,150,080	4,318,551	552.	89,959,360	75,465,444

**Table Showing Work Done with Worthington Duplex Engine for each Month During the Year 1886.**

MON. HS.	No. of days of Pump- ing.	Ave. No. of hours Pumping per day.	No. of hours Pumping per month.	No. of strokes made per month.	Ave. No. of strokes made per minute.	Ave. head including friction in feet.	Quantity Pumped per month in U. S. gallons.	Ave. quantity Pumped per day in U. S. gallons.	No. galls. of water raised in reservoir per day of total coal consumed.	Duty in lbs. 100 lbs. coal used in pump- ing only, no deduction for ashes or clinkers.	Duty on total coal consumed no deduction for ashes or clinkers.
January . . . .	8	21-25	64-15	42,199	10.95	165.88	13,081,690	4,360,563	426	69,825,097	58,907,812
February . . . .	6	22-35	135-30	92,275	11.35	165.78	28,605,250	4,767,542	437	70,953,881	60,337,886
March . . . . .	9	16-37	149-35	73,425	8.18	169.21	22,761,750	2,529,083	414	66,182,542	58,360,963
April . . . . .											
May . . . . .	11	17-22	191-00	150,929	13.17	163.55	46,787,990	4,253,454	433	70,702,034	59,049,285
June . . . . .											
July . . . . .	7	18-59	132-55	105,722	13.26	164.58	32,773,820	4,681,974	425	69,052,051	58,229,137
August . . . . .											
September . . . .											
October . . . . .	10	14-03	140-30	123,872	14.69	164.38	38,400,320	3,840,032	444	72,063,847	60,886,863
November . . . .	15	11-33	173-10	119,554	11.51	166.41	37,061,740	2,470,783	435	70,506,841	60,328,082
December . . . .											
Totals and Averages.	61	16-11	986-55	707,976	11.96	165.68	219,472,560	3,597,911	432	70,262,694	59,654,078



**Table Showing Amount of Coal Used for Morris Engine at Pumping Station During the Year 1886.**

MONTHS.	COAL CONSUMED.			
	For starting fires In Pounds.	When Pumping In Pounds.	For banking fires In Pounds.	Tot'l per Month In Pounds.
January . . .	26,400	185,250	10,200	221,850
February . . .	24,000	159,100	8,900	192,000
March . . .	24,000	171,900	8,800	204,700
April . . . .	22,200	156,100	8 200	186,500
May . . . . .	12,300	83,000	4,800	100,100
June . . . . .	24,000	174,100	8,500	206,900
July . . . . .	21,000	154,250	7,400	182,650
August . . . .	25,200	192,000	9,400	226,600
September . .	23,400	175,850	8,600	207,850
October . . .	13,800	99,900	5,400	119,100
November . .	15,000	99,200	5,800	120,000
December . .	28,800	207,100	10,400	246,300
Totals . . .	260,100	1,857,750	96,700	2,214,550

**Table Showing Amount of Coal Used for Worthington Duplex Engine at Pumping Station During the Year 1886.**

MONTHS.	COAL CONSUMED.			
	For starting fires In Pounds.	When Pumping In Pounds.	For banking fires In Pounds.	Tot'l per Month In Pounds.
January . . .	3,600	25,900	1,200	30,700
February . . .	7,200	55,700	2,600	65,500
March . . . .	3,900	48,500	2,600	55,000
April . . . . .				
May . . . . .	14,400	90,200	3,400	108,000
June . . . . .				
July . . . . .	9,900	65,100	2,200	77,200
August . . . .				
September . .				
October . . .	10,800	73,000	2,600	86,400
November . .	8,700	72,900	3,600	85,200
December . .				
Totals . . .	58,500	431,300	18,200	508,000

MONTHS.	No. of days Pump ing.	Average number of hours pumping per day.	Number of hours Pumping per month.	Number of strokes made per month.	Average number of strokes made per minute.	Average head including friction in feet.	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. Gallons.	No. of gallons of water pumped into reservoir per lb. of total coal consumed.	Coal in lbs. used when pumping.
January, . . . .	4	12-45	51-00	184,174	43.85	78.39	1,878,436	469,609	318	5,900
February, . . .	3	13-10	39-30	97,531	41.15	78.27	1,365,434	455,145	307	4,450
March, . . . . .	5	10-03	50-15	131,501	43.62	78.90	1,841,014	368,203	321	5,780
April, . . . . .	3	11-20	34-00	77,364	37.92	78.67	1,083,096	361,032	308	3,510
May, . . . . .	4	11-15	45-00	101,786	37.70	78.67	1,425,004	356,251	351	4,060
June, . . . . .	4	13-08	52-30	121,691	38.63	78.67	1,703,674	425,918	328	5,200
July, . . . . .	6	15-30	93-00	176,186	31.57	79.06	2,466,604	411,101	320	7,700
August, . . . . .	5	11-06	55-30	135,087	40.57	78.67	1,891,218	378,244	324	5,840
September, . . .	4	10-56	43-45	103,241	39.33	78.67	1,445,374	361,343	316	4,570
October, . . . . .	5	11-24	57-00	121,172	35.43	78.20	1,696,408	339,282	320	5,300
November, . . .	4	10-15	41-00	89,799	36.50	77.51	1,257,186	314,297	314	4,000
December, . . .	5	14-12	71-00	157,091	36.88	78.67	2,199,274	439,855	323	6,800
Totals and Averages,	52	12-11	633-30	1,446,623	38.06	78.53	20,252,722	389,475	321	63,060

## PUMPING STATION, MORRIS ENGINE.

*Running Expenses for the Year 1886.*

Pay of engineers and firemen.....	\$3,219.15
775 $\frac{848}{2000}$ tons coal (Powelton 1885), at \$3.72.....	2,884.58
71 $\frac{870}{2000}$ tons coal (Cumberland, 1886), at \$5.268.....	376.32
25 $\frac{850}{2000}$ tons coal (Elk Garden, 1886), at \$4.018.....	101.72
235 $\frac{802}{2000}$ tons coal (George's Creek, 1886), at \$4.152.....	976.14
1 cord of wood.....	3.75
Gas for lighting works.....	104.14
69 pounds tallow, at 4½c.....	3.11
126 gallons cylinder oil, at 50c.....	63.00
106 gallons crude and cold test oil at 2018c.....	21.71
52 gallons lard oil, at 514c.....	26.73
165 pounds cotton waste, at 12½c.....	20.63
63 pounds soapstone packing, at 30c.....	18.90
21 pounds hemp packing, at 20c.....	4.20
2¼ pounds Jenkin's packing, at 80c.....	1.80
Repairs on engine.....	31.17
Repairs on boilers.....	33.78
Tools and stock.....	30.72
Engine register book.....	12.00
Sundries.....	31.46
Total.....	\$7,965.01
Cost of raising water into reservoir, per million gallons.....	\$6.52
Cost of raising water one foot high, per million gallons.....	.03 $\frac{57}{100}$

## WORTHINGTON ENGINE.

*Running Expenses for the Year 1886.*

Pay of engineers and firemen.....	\$613.17
168 $\frac{800}{2000}$ tons coal (Powelton, 1885), at 3.72c.....	625.70
85 $\frac{1600}{2000}$ tons coal (George's Creek, 1886), at 4.152c.....	356.24
$\frac{8}{10}$ cords wood.....	2.25
Gas for lighting works.....	19.84
20½ gallons cylinder oil, at 50c.....	10.25
8 gallons lard oil, at 514c.....	4.11
27 pounds cotton waste, at 12½c.....	3.37
9½ pounds soapstone packing, at 30c.....	2.96
Repairs on boilers.....	5.50
Tools and stock.....	5.00
Sundries.....	5.12
Total.....	\$1,653.51
Cost of raising water into reservoir, per million gallons.....	\$7.53
Cost of raising water one foot high, per million gallons.....	.04 $\frac{53}{100}$

## RESERVOIR, BEACON STREET, 1886.

MONTHS.	Depth in Feet.	Quantity in U. S. Gallons.	Temperature in Degrees.	
			Of Water.	Of Air. °
January . . . . .	18.17	27,449,500	32.81	24.39
February . . . . .	17.56	26,451,600	32.03	25.02
March . . . . .	17.76	26,784,400	33.07	33.54
April . . . . .	17.75	26,766,500	45.08	52.05
May . . . . .	17.91	27,020,400	57.77	*
June . . . . .	17.68	26,650,100	65.09	*
July . . . . .	17.73	26,726,800	71.40	*
August . . . . .	17.57	26,459,800	71.36	*
September . . . . .	18.09	27,329,700	67.23	58.92
October . . . . .	17.96	27,101,400	54.57	50.33
November . . . . .	18.31	27,684,000	41.78	41.47
December . . . . .	17.82	26,870,800	32.30	27.04

\* Temperature not taken.

Table showing the average monthly and daily consumption of water for the year 1886 :

MONTHS.	Gallons per Month.	Gallons per Day.
January . . . . .	140,355,850	4,527,610
February . . . . .	137,981,300	4,927,900
March . . . . .	130,620,660	4,213,570
April . . . . .	104,717,750	3,490,590
May . . . . .	105,907,730	3,416,380
June . . . . .	117,115,710	3,903,860
July . . . . .	126,609,130	4,084,170
August . . . . .	121,600,750	3,922,610
September . . . . .	110,809,550	3,693,650
October . . . . .	106,653,880	3,440,450
November . . . . .	105,500,410	3,516,680
December . . . . .	136,668,210	4,408,650
Total and average . . . . .	1,444,540,930	3,957,650

Respectfully submitted,

GEORGE E. EVANS, *City Engineer.*

**FOURTEENTH ANNUAL REPORT**  
**OF THE**  
**Superintendent of Water Works,**  
**TO THE**  
**LOWELL WATER BOARD.**

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**JANUARY 1, 1887.**



# REPORT OF THE SUPERINTENDENT.

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SUPERINTENDENT'S OFFICE, CITY HALL,  
LOWELL, JANUARY 1st, 1887.

*To the Lowell Water Board:*

GENTLEMEN:—In compliance with the requirements of the City Ordinance relating to the Water Works, I respectfully submit herewith the Fourteenth Annual Report of the Superintendent of the Lowell Water Works, for the year ending December 31st, 1886.

The total amount of water pumped into the reservoir during the year was 1,441,622,640 gallons being an increase of 141,856,360 gallons over the amount pumped in 1885, and assuming the number of water users to be 65,000 will give an average daily consumption of about 60 gallons of water for each consumer. This of course includes all the water used for every purpose, such as domestic use, manufacturing, and for extinguishing fires, also water for steam boilers, drinking fountains, sprinkling streets, etc. The total quantity sold by meter measurement amounts to 326,999,950 gallons, an increase over last year of 10,580,900 gallons. The works are all in good condition. All needed repairs have been made together with many improvements.

## FILTER GALLERY AND CONDUIT.

An inspection of the filter gallery showed that but a slight amount of sediment had collected on the bottom, while the sides and top were clean and in good condition.

The conduit has been blown off three times this season, in order to carry off the sediment which accumulates on the bottom after every freshet in the river. No repairs have been made on either the gallery or conduit this year.

## PUMPING STATION.

The Morris engine has pumped 1,222,150,080 gallons and the Worthington has pumped 219,472,560 gallons of water into the reservoir. No repairs of any account have been made on either of



the engines or boilers. The rear of the coal shed has been extended back nine feet, giving room for storing about two hundred tons more coal than formerly. At the front of the shed, a shop has been built on and fitted up with tools for general repairs, including all the repairs of meters, etc.

The windows in the engine room have been lowered twenty-two inches, and lights of colored glass set between the upper and lower sashes, giving a much better outlook to the room.

An enclosed railing has been placed around the flywheel, and a small entrance door cut through the large doors in front of the building. A large storehouse has been built back of the coal shed, and the anterior portion of the grounds enclosed by a new slat fence.

An examination of the lightning rod on the boiler house chimney, showed it to be so badly corroded as to be practically useless, and after much inquiry and study of lightning rods, it was decided to put on a solid copper rod made by the R. I. Telephone and Electric Co. of Providence. The rod has for a ground connection, the six inch water main on Hampshire street. A new iron ladder has been attached to the outside of the chimney reaching to the top.

The coping around the chimney has been repaired and the cap repainted. The dwelling occupied by the engineer and the one also at the reservoir, were both in a dilapidated condition, but few repairs having been made on them since they were purchased. These have now been put in good repair, painted, papered and shingled, and are now in condition to last many years without much more expense.

#### HIGH SERVICE.

20,252,722 gallons of water have been pumped into the high service reservoir during the year, an increase of 1,860,684 gallons over last year. No extensions or services have been added to the high service system this year.

#### RESERVOIR.

For several years usually during the month of February the water in some sections of the city has developed a peculiar odor which has been designated as "swampy" and could be easily detected by any one placing their face close to a fresh drawn basin of water. The reason of this was attributed to the fact that in every case where the smell had been noticed, the reservoir as well as the river had for several weeks previous been covered with ice, leaving no chance for the air to get to the water. Last winter, as an experiment, the gate

connecting the inlet chamber of the reservoir with the 30-inch pipe through which the water flows to the opposite side of the reservoir was closed, and at the mouth of the overflow weir, an apron was built of 2-inch plank 6 inches wide, laid with 1 inch space between each plank, and a 3 inch joist fastened around the rim of the apron. So that as the water is pumped over the weir, it flows into this apron, and drops into the reservoir either through the cracks, or over the sides, and falling from two to six feet according to the height of water in the reservoir, it gets thoroughly aerated before passing into the main, and since this device has been adopted, the swampy smell has disappeared.

The debris remaining from last year's repairs at the reservoir has all been utilized by widening the westerly and part of the northerly slope, making these banks now five feet wider at the bottom of the slope, and three feet wider at the top, the loam being previously removed from the slopes, and replaced again after the debris had been wheeled on and well rolled and puddled. Portions of the slopes and surrounding grounds, were then ploughed and sowed with grass seed. Iron steps made by the No. Chelmsford Foundry Co. have been set at the entrance to the gate house, and a drain of 8-inch Akron pipe with four cesspool connections, has been laid from the Beacon street sewer along the foot of the northern slope a distance of 675 feet.

#### EXTENSIONS.

Two miles two hundred and forty-three feet of cast iron mains have been laid this year. A twelve-inch main with two expansion joints, has been laid across Merrimack river under the westerly sidewalk of central bridge, and connected with the twelve-inch mains on each side of the river, so that we have now four independent lines leading from the reservoirs to the city proper. A connection controlled by a twelve-inch gate has also been made with the 24-inch force main on Sixth street, to the 12-inch main on Bridge street. So that in case of any accident to the reservoir, or in case of a large fire, the water can be pumped directly into the city mains, giving an additional supply to that furnished by the reservoir alone. Connections on both sides of the river at Hunt's falls have been made with the 30-inch main to the 24-inch reserve line, by a system of gates, so that in case of any accident in the river to either the high service or low service mains, the water can in a few moments be switched into the 24-inch reserve line.



## LEAKS.

There have been two leaks in joints of the force main, six leaks in joints of the supply mains, one break in pipe on L street. Two blank heads started off, on the high service line, caused by the backing being taken away by parties building a house drain, ten service pipes have broken off, principally occasioned by the settling of sewer trenches, and one twelve-inch special broke on the corporation line on Hall street.

## HYDRANTS.

Thirteen new hydrants have been set on extensions. The old style hydrant on Adams street, near Broadway, has been changed for a new flush hydrant, the old style hydrant on Mt. Vernon street near Broadway, and the one on Broadway near school street, also the new flush hydrant on Suffolk street, near Lagrange street, have been discontinued and replaced by new post hydrants. An inspection of every hydrant in the city is made twice every year by the Fire department, who report every hydrant which is not in perfect order. Fifty-nine cases were reported this year, but only twenty-six needed more than slight repairs, and none of them were out of order so but what they could have been used if necessity required.

## SERVICES.

241 services have been added this year. 150 old services have been changed for either lead or larger iron, and 22 services have been discontinued and cut off at the main.

The amount of service pipe laid in 1886 is as follows :

$\frac{3}{4}$ inch wrought iron pipe.....	520 feet.
1 " " " " .....	449 "
$1\frac{1}{4}$ " " " " .....	33 "
2 " " " " .....	38 "
$\frac{5}{8}$ " lead pipe.....	6,449 "
$\frac{3}{4}$ " " " " .....	789 "
1 " " " " .....	249 "

Total laid during 1886..... 8,527 "

Amount previously laid..... 267,291 "

Total amount now laid..... 275,818 "

Or 52 miles 1258 feet.

Total number of services put in..... 7,448

Total cut off at main..... 341

Total reconnected..... 20

Total now in use..... 7,127

25 services have been shut off for non payment; 2 have been remitted, 13 paid, and 10 remain unpaid.

## Number and Kind of Services Changed During the Year Ending Dec. 31, 1886.

SIZE OF SERVICE CHANGED FOR.		$\frac{1}{2}$ in. lead.	$\frac{3}{4}$ in. lead.	1 in. lead.	1 in. lead.	1 in. iron.	$1\frac{1}{4}$ in. iron.	$1\frac{1}{2}$ in. iron.	2 in. iron.	$2\frac{1}{2}$ in. iron.	
79	$\frac{3}{4}$ inch. iron.	2792									2792 feet
47	$\frac{3}{4}$ inch. "		2041								2041 "
10	$\frac{3}{4}$ inch. "			425							425 "
2	1 inch. "				65						65 "
7	$\frac{3}{4}$ inch. "					448					448 "
1	$\frac{3}{4}$ inch. "						71				71 "
1	1 inch. "							54			54 "
1	$\frac{3}{4}$ inch. "								39		39 "
2	1 inch. "									155	155 "
150	Totals . .	2792	2041	425	65	448	71	54	39	155	6090 feet

## Schedule of Small Pipe Laid.

STREETS.	1 inch.	Total feet.
Court off Coburn Street . . . . .	148	148 feet.
Stanley Avenue . . . . .	108	108 "
South Hastings Street . . . . .	22	22 "
Total . . . . .	278	278 feet.

## METERS.

There are now in use 1461, an increase over last year 40; meters set during the year, 60; meters taken out and repaired, 293; meters taken out and others set in their places, 43; Worthington meters taken out, cleaned and repaired, 80; Desper meters repaired at Worcester, 89; Desper meters repaired at Pumping Station, 80; meters worn out and replaced by others, 13; meters destroyed by freezing, 16; meters discontinued, 15.

## Meters Running January 1, 1887.

SIZE IN INCHES.	$\frac{1}{2}$ in.	$\frac{3}{4}$ in.	1 in.	$1\frac{1}{2}$ in.	2 in.	3 in.	4 in.	Motor Regis- ters.	Total.
Desper . . . .	505	154	65	1					725
Worthington . . .	281	27	49	70	25	5	2		459
Crown . . . . .	67	94	32		2		1		196
Duplex . . . . .	13	14	10						37
Ball & Fitts . . .	19	9	2	1					31
Fitts Rotary . . .	7		1						8
Motor Registers .								5	5
Total . . . . .	892	298	159	72	27	5	3	5	1461

## ITEMS OF OTHER WORK DONE.

Two years ago an examination of the trusses supporting the twenty-four-inch main which crosses Concord river under East Merrimack street bridge, showed that they had deflected from a straight line and canted down stream. An examination this year showed that the deflection had increased so much that there was danger of the trusses tripping and letting the pipe into the river. The cause of this was owing to the ends of the trusses resting on loose stones, on both abutments and pier, and as the pipe was originally laid crowning, when the trusses settled the pipe crowded against the timber on the down stream side and caused the trusses to cant. The pipe had to be shored up by timbers reaching from the bottom of the river. The trusses were then brought back into place, and held by braces and rods, also by rods running diagonally from the centers to the up stream end of the abutments and pier. The ends of the trusses were then secured in masonry on a firm foundation, so that no trouble need hereafter be apprehended.

A six-inch blow-off has been laid on Front street, and the mains throughout the city have been blown out twice this year. All the service boxes, hydrants boxes, street gate boxes and gates, have been examined and put in good order. 385 unsound service boxes have been replaced by the pipe service box manufactured by Staples Bros. of this city. 11 decayed hydrant boxes have been replaced by cast iron boxes and 33 street gates were found leaking and were

repaired. A pipe drinking fountain has been set on Branch street near the Franklin school house. The stone troughs at Middlesex Village and on Bridge street in Centralville, have been removed and changed for pipe fountains, and the stone trough in Liberty square has been replaced by a large circular fountain made by the Mott Iron Works of New York.

CONCLUSION.

In closing this report I desire to extend to the President and members of the Water Board my sincere thanks for their uniform courtesy and co-operation in the discharge of the duties of my position.

Respectfully submitted,

HORACE G. HOLDEN, Supt.



## Low Service.—Water Pipes Laid in 1886.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.					Total.
		4 in.	6 in.	8 in.	12 in.	24 in.	
Anderson . .	Extended easterly . .		183				183
Aiken Ave. .	Southerly toward Hildreth .		144				144
Baldwin . . .	Southerly from Middlesex .		1583				1583
Bartlett . . .	Easterly from Alder . .	335					335
Barker Ave. .	Southerland and W. 19th .		285				285
Bridge . . .	Force main and Bridge st. line				39		39
Bridge . . .	Across Central bridge . .				553		553
Boynton . . .	Extended easterly . .		127				127
Chester . . .	Westford and Princeton .		352				352
Gorham . . .	Southerly toward Chelmsford line . . .		479				479
Hazeltine . .	Frye and Powell . . .	114					114
High . . .	Southerly to Rogers . .		1048				1048
Lawrence . .	S'e'ly beyond Dugdale's house			363			363
Lawson . . .	Queen and School . .	122					122
Leverett . . .	Extended Southerly . .	98					98
Lundberg . .	Gorham and O'Connell . .	38	333				371
Maple . . .	Extended easterly . .	75					75
McIntire . .	Northerly from Marshall .	210					210
O'Gonnell . .	Lundberg st. northerly . .	144					144
Pine . . .	Baldwin st. Ely . . .		258				258
Pleasant, Ward 2	Southerly from West st. .		351				351
Rockdale Ave.	Bowers and Fletcher st. .	408					408
Rogers Ave. .	Rogers st. and Fort Hill Park		506				506
Rogers . . .	High and Rogers ave. . .		357				357
Second Ave. .	Extended southwesterly .		195				195
Varnum Ave.	Extended westerly from Fay's		1472				1472
Ward . . .	Northerly from Tucker .		238				238

**Low Service.—Water Pipes Laid in 1886.—Concluded.**

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.					Total.
		4 in.	6 in.	8 in.	12 in.	24 in.	
Wilder . . .	Extended n'y toward Pawt'kt	44					44
W. Nineteenth,	Southerly to Barker ave. .	53					53
Front . . .	Blow off . . . . .	24					24
Fire Service .	Thorndike Manufacturing Co.	54					54
Reserve Line .	North side Merrimack river .				14		14
Reserve Line .	South side Merrimack river .				16		16
	Hydrants . . . . .	188					188
Laid in 1886 . . . . .		1544	8255	363	592	30	10,803
Low service laid previous to 1886 . . . .							403,261
Total low service to Jan. 1, 1887 . . . .							414,064
High service pipes laid to Jan. 1, 1887 . . .							15,171
Total high and low service to Jan. 1, 1887 .							429,235
Total in miles to Jan. 1, 1887 . . . . .							81.30



## Low Service.—List of Hydrants Set During the Year 1886.

STREET <sup>s</sup> .	LOCATION.
Aiken Ave. . .	Northwesterly side, opposite West Nineteenth street.
Anderson . . .	Southerly side, 429½ feet from Gorham street.
Baldwin . . .	Easterly side, 1550 feet from Middlesex street.
Bartlett . . .	Northerly side, 15 feet easterly from Alder street.
Bowers . . .	Northerly side, opposite Rockdale avenue.
Gorham . . .	Westerly side, 121 feet from town bound.
Lawrence . . .	Easterly side, about 196 feet southerly from Dugdale's house.
Lagrange . . .	Northerly side, 3 feet west from Suffolk street.
Mt. Vernon . .	Westerly side, 46 feet north from Broadway.
Pine . . . . .	Northerly side, 242 feet from Baldwin street.
Rogers . . . .	Northerly side, opposite Rogers avenue.
School . . . .	Westerly side, 7 feet south from Broadway.
So. Loring . .	Westerly side, 325 feet from Liberty street.
*Stackpole, w'y end . . . . .	Easterly side, street 152.5 feet from East Merrimack street.
Varnum Ave.	Northerly side, nearly opposite Harlow Hull's house.
Varnum Ave.	Northerly side, nearly opposite Thomas Varnum's house.

\* Flush hydrant.

## DISCONTINUED.

Flush hydrant on westerly side Mt. Vernon street, about 16 feet north of Broadway.

Hydrant on easterly side Suffolk street, opposite Lagrange.

Flush Hydrant on Broadway at northeast corner of School street.

## Low Service.—List of Stop Gates Set During the Year 1886.

STREETS.	LOCATION.	4in.	6in.	12in.
Baldwin . . . . .	19 ft. w'ly from e'ly line Baldwin St., 16 ft. n'ly from s'ly line Middlesex St.		1	
Bridge . . . . .	22.3 ft. e'ly from w'ly line Bridge St., 18 ft. s'ly from n'ly line W. Sixth St.			1
Chester . . . . .	16.3 ft. w'ly from e'ly line Chester St., 4.3 ft. n'ly from n'ly line Westford St.		1	
High . . . . .	19 ft. e'ly from w'ly line High St., 2 ft. n'ly from n'ly line Rogers St.		1	
Lundberg . . . . .	About 13 ft. n'ly from s'ly line Lundberg St., 1.8 feet e'ly from e'ly line Gorham St.		1	
Pleasant (Ward 2) .	32.5 ft. w'ly from e'ly line Pleasant St., 27 ft. s'ly from s'ly line W. Sixth St.		1	
Rockdale Ave. . .	5 ft. east of west line Rockdale Ave., on s'ly line Bowers St.	1		
Thorndike st. (Thorndike M'fg Co., fire service.)	5.7 ft. east of w'ly line Thorndike St., 2 ft. n'ly of w'ly wall, new mill.		1	
Front street, blow off.	14 ft. east of east line Front St., about 16 ft. south of north line Front St.		1	

Schedule of Main Pipe and Special Castings.

DIAMETER IN INCHES.	4	6	8	10	12	16	20	24	30
Lengths . . . . .	68	21	13	25	75	5	17	8	5
Sleeves . . . . .	6	1	10	1	15	10	4	9	6
Caps . . . . .	2	6	23	8	16	3	1	1	
Curves . . . . .	16	6	12	2	9	4	10	3	

DIAMETER IN INCHES.	4x4	6x4	6x6	8x6	8x8	10x6	10x8	12x6	12x8	12x10	12x12	16x6	16x8	16x12	16x16
3-Ways . . . . .	4	4	6			2	12	7					1		
4-Ways . . . . .	2		2	4	5		6	1		1				1	1
Reducers . . . . .			9		5		2	4	5	4				1	

## Property in Water Board and Superintendent's Office.

17 chairs, 4 high stools, letter press, 7 desks with drawers, 3 standing desks, 3 office tables, 1 book case in vault, 1 black walnut book case, 1 book rack, 1 bill cabinet, 10 ink stands, 1 clock, 1 glass mug, 3 waste baskets, 8 spittoons, 4 wrenches, 1 pick, 1 map of distributing pipes, 1 large rubber mat, 3 grass mats, 1 water gauge, 1 screw driver, 1 safe, 1 key rack, 1 atlas of Lowell, 1 instrument for testing capacity of engines, 1 apparatus for marking gates, 1 hat rack, 1 umbrella rack, 1 water cooler, 1 settee.

## Property at Pipe Yard January 1, 1887.

**Meters.**—Worthington Meter.—1 $\frac{5}{8}$  inch, Desper Meter.—3 $\frac{5}{8}$  inch, 1 inch, Crown Meter.—4 $\frac{5}{8}$  inch, 1 $\frac{3}{4}$  inch. **Second Hand Meter's.**—Worthington 16, Ball & Fitts 6, Fitts Rotary 5, Duplex 3, Worthington Meter bottoms 3, tops 10, indicator 31, covers 16, valves and valve seats 12, spindles 15, out and inlets for Desper Meter 35, 6 head connections for taking out Worthington Meters, 3 set packing patterns, 1 roll paper packing, 1 lb. sealing wax,  $\frac{1}{6}$  box crayons,  $\frac{1}{2}$  box candles, 10 lbs. leather, 2 oil pans, 1 pair cut nippers, 2 brass lamps, 1 pair pliers, 1 leather tool bag, 2 match safes, 200 brass unions for  $\frac{5}{8}$  in. meters, 25 brass nipples, and unions for 1 inch meters, 12 brass nipples and unions for 1 $\frac{1}{2}$  inch meters, 4 brass nipples and unions for 2 inch meters, 1 5 gallon can, 2  $\frac{1}{2}$  gallon, 2  $\frac{1}{4}$  gallon, 1 seive, 1 pall, 1 tank, for testing meters, 1 platform scale, 1 counter scale, 2 chairs, 1 desk, 1 portable closet, 1 clock, 6 pair pipe tongs, 2 stilson wrenches, 4 monkey wrenches, 5 screw drivers, 1 mallet, 2 claw hammers, 1 hatchet, 1 foot lathe, 1 lathe dog, 1 broom, 1 coal stove, 1 coal hod, 2 bit stocks, 2 bits, 7 hand saws, 100 lbs. old brass, 2 solder irons, 1 2 inch auger, 1 set numbers, 1 fore plane, 1 bench block, 1 universal chuck, 2 small hammers. **Stop Gates.**—1 4 inch, 1 8 inch, 1 12 inch, wrought iron pipe, 150 ft. 1 inch, 1 pipe reel, 50 ft.  $\frac{3}{4}$  inch lead pipe, 1 reel  $\frac{3}{4}$  inch lead pipe, 1 reel 1 inch pipe, 7  $\frac{3}{4}$  inch tees, 21 1 $\frac{1}{2}$  inch, 20 2 inch. **Crosses.**—13 1x $\frac{3}{4}$  inch, 8 1 inch, 8  $\frac{3}{4}$  inch, 16 2x1 inch. **Couplings.**—150 assorted **Elbows.**—35 1x $\frac{1}{2}$  inch, 5  $\frac{3}{4}$  inch. **Bushings.**—50 assorted, **Reducing Couplings.**—30. **Plugs.**—35 1 inch, 40 1 $\frac{1}{2}$  inch. **Unions.**—43 1 $\frac{1}{2}$  inch



20 2 inch. *Solder Nippers*.—25  $\frac{3}{4}$  inch, 20  $1\frac{1}{2}$  inch. *Solder Unions*.—30 1 inch, 18  $\frac{7}{8}$  inch, 40  $\frac{5}{8}$  inch. *Corporation Cocks*.—30 1 inch, 40  $\frac{5}{8}$  inch. *Stop and Waste Cocks*.—3  $1\frac{1}{2}$  inch, 12 1 inch, 70  $\frac{5}{8}$  inch. *Cellar Cocks*.—15 1 inch, 8  $\frac{5}{8}$  inch. *Sidewalk Cocks*.—5  $\frac{5}{8}$  inch. *Brass Tees*.—25  $\frac{3}{4}$  inch, plugs, 15  $\frac{3}{4}$  inch, 6 iron hydrant boxes, 2 stop-gate boxes, 1 wood hydrant box, 100 iron sidewalk boxes, 35 joints earthen pipe for sidewalk boxes, 2 saw horse, 1 buck saw, 1 machine for testing main pipe, 2 pipe benches, 3 tool boxes, 3 derricks, 2 fall ropes, 2 set of blocks, 6 draught chains, 5 wheelbarrows, 2 tongs for cleaning sidewalk boxes, 5 hydrant frames, 15 hydrant covers, 6 gate box frames, 6 gate covers, 3 set castings for drinking fountains, 20 picks, 25 pick handles, 8 square shovels, 20 shovels, round point, 16 scrub brooms, 6 hand brushes, 17 pair rubber boots, 13 lanterns, 30 ft. rubber hose, 1 hose reel, 2 brass goose necks, 6 calking sets, 4 nail hammers, 150 sidewalk caps, 200 feet canvass hose, 30 iron lug straps, 250 lbs. assorted bolts, 12 assorted files, 12 assorted gravel screens, 30 lbs. cotton waste, 2 trowels, 10 lbs. iron washers, 30 lbs. assorted nuts, 3 hand hatchets, 1 ax, 5 sling ropes, 1 dualin pot, 1 10 gallon can, 9 striking hammers, 5 hand hammers, 5 hand hammer handles, 1 16 foot straight edge, 385 pig lead, 3 set old blocks, 2 lead pots, 1 furnace for melting lead, 1 zinc pump, 2 copper force pumps, 1 keg 10d nails, 1 keg 30d nails, 40 assorted wrenches, 14 rammers, 3 paving mauls,  $\frac{1}{4}$  barrel cement,  $\frac{1}{4}$  barrel white clay, 2 snow shovels, 1 blacksmith shop, 1 work shop, 1 carriage house, 1 stable, 1 store shed, 2 spirit levels, 1200 feet lumber for gate and hydrant boxes, 2 patterns for making gate and hydrant boxes, 1 set blacksmith tools, 400 lbs. steel in drills, 4 scrapers for blasting purposes, 4 lbs. pipe wedges, 3 yarning irons, 2 lead ladles, 8 crow bars, 3 horses, 3 express wagons, 1 light wagon, 3 horse blankets, 2 pungs, 1 sleigh, 2 horse brushes, 4 harnesses, 2 hay forks, 2 manure forks, 1 wagon jack, 2 wagon wrenches, 2 canvass covers for horses,  $2\frac{1}{2}$  tons hay, 7 post hydrants, 6 flush hydrants, 15 second hand old style hydrants, 12 pair pipe tongs, 2 stilson wrenches, 4 monkey wrenches, 3 tapping machines, 20 dippers for drinking fountains, 125 feet block tin tubing, 1 30 foot extension ladder, 2 24 foot ladders, 2 ratchet cutters, 3 pipe cutters, 3 pipe vices, 20 dies, 2 ratchet die plates, 1  $3\frac{3}{4}$  inch tap, 1 1 inch, and 1  $1\frac{1}{2}$  inch, 4 oil cans, 100 feet block tin wire, 1 solder pot, 2 solder moulds, 1 charcoal furnace, 3 bbl. charcoal, 1 naphtha furnace, 5 soldering irons, 15 gate spindles, 2 disks, 11 hydrant spindles, 8 hydrant valves, 12 hose, 30 hydrant packings for top, 30 hydrant packings for bottom, 34 5 inch packings for top, 34 hydrant packings for bottom, 10 packings for 4 inch gates, 1 packing for 16 inch gate, 1 map of distributing main pipe, 1 map of showing stop gates, 1 map of Lowell, 1 map of United States, 1 Edison patent pump, 9 feet 4 inch rubber hose, 1 ton stove coal, 5 lbs. shims and wedges, 2 portable closets, 1  $\frac{1}{4}$  gross lamp wicks, 1 coal hod, 2 chairs, 1 desk.

#### Property at Pumping Station.

1 vise, 1 work bench, 1 portable forge, 8 sets of brasses for engines, 2 sets differential blocks, 1 piece 2 inch rope, 1 set fire irons, 1 brass hydrant, 2 axes, 11 wrenches, 3 hand saws, 2 jack screws, 12 cold chisels, 2 ratchet drills, 1 socket drill, 3 calking chisels, 1 barometer, 2 thermometers, 1 desk, 2 indicators, 1 oil cupboard, 2 oil dishes, 1 platform scale, 4 crow bars, 64 feet  $\frac{5}{8}$  inch chain, 16 eye bolts, 1 truck, 1 key wrench for air pump, 2 iron wheelbarrows, 1 buck saw, 2 gas lamps, 1 high grade thermometer, 4 brass bolts,  $\frac{1}{2}$  inch diameter, for pump valves, 5 spare pump valves, 5 sets spare weights for valves, 11 wrenches for Morris engine, 11 finished wrenches for Worthington engine, 3 sledge hammers, 10 drills a-sorted sizes, 2 bit stocks, 5 bits, 1 25 foot ladder, 1 20 foot, 1 18 foot ladder, 1 pair steps, 1 hoe, 2 rakes, 1 small die plate, 1 fore plane, 5 monkey wrenches, 100 feet 2 inch rope, 4 chisel bars, 6 small taps, 4 finished socket wrenches for Worthington engine, 3 14 quart iron pails, 4 hand hammers, 2 grind stones, 1 anvil, 7 pairs gas tongs, 1 wrench, 11 finished wrenches, 2 clocks, 1 set Walworth's solid dies from  $\frac{1}{4}$  inch to 2 inch right and left, 2 die stocks,

and bushings, 2 sets, 2 sheave blocks, 3 pieces  $\frac{1}{2}$  inch chain, 1 24 inch elbow for Worthington force main, 1 24 ratchet wrench for 30 inch gate river crossing, 1 scythe, 1 snath, 7 chairs, 1 desk, 1 table, 2 engine lathes, 1 speed lathe, 1 up-right drill, 31 turning tools, 1 12 inch chuck, 1 6 inch chuck, 1 No. 3 drill chuck, 1 No. 2 drill chuck 3 reamers Desper meters, 3 small reamers, 2 small taps, 16 twist drills, 4 lanterns.

#### **Property at Reservoir.**

1 iron tooth rake, 1 hay fork, 3 shovels, 2 long handle shovels, 1 ax, 1 piece 1 inch rope, 1 scythe, snath, 1 grass hook, 10 wheelbarrows, 3 thermometers, 1 stop gate wrench, 1 sidewalk wrench, 1 coal stove, 2 lanterns, 1 ice chisel, 1 nail hammer, 1 saw, 1 carpenter's square, 2 hoes, 1 piece rubber hose, 2 chairs, 1 sectional ladder, 1 dwelling house, 1 stable.

#### **Tools and Property at Filter Inlet.**

2 iron tooth rakes, 11 shovels, 1 rammer, 1 ax, 2 ice chisels, 1 stop gate wrench, 1 nail hammer, 1 pick, 2 brooms, 1 wheelbarrow, 1 boat, 1 set of oars.

# SUMMARY OF STATISTICS.

REPORT OF 1886.

IN ACCORDANCE OF SUGGESTIONS ADOPTED BY THE NEW ENGLAND WATER  
WORKS ASSOCIATION.

## Lowell Water Works, Lowell, Mass.

Population by census of 1885, 64,051.

Date of construction, 1870 to 1872, inclusive. Owned by the City of Lowell.

The source of supply is from Merrimack River.

The mode of supply is by pumping and consists of one Morris pump, and one Worthington pump, of 5,000,000 gallons daily capacity each.

The kind of coal used is Maryland Co.'s Cumberland.

Cost of coal is \$4.65 per ton of 2240 lbs.

	MORRIS.	WORTHINGTON.
Coal consumed for the year in pounds . . . . .	2,214,550	508,000
Total pumping in gallons . . .	1,222,150,080	219,472,560
Average head including friction in feet . . . . .	164.08	165.68
No. of gallons pumped per lbs. of coal . . . . .	552	432
Duty on total coal consumed, no deduction for anything . . .	75,465,444	59,654,078
Cost of pumping figured on pumping station expenses, viz: . .	\$9,618.52	
Per million gallons into reservoir	6.52	\$7.53
Per million gallons one foot high	03.1 <sup>7</sup> / <sub>100</sub>	04.1 <sup>8</sup> / <sub>100</sub>

## Financial.

RECEIPTS.	EXPENDITURES.
Water rates . . . . . \$165,279.68	Construction . . . . . \$ 15,175.55
Services, meters, etc. . . . . 3,477.75	Maintenance . . . . . 35,253.47
Appropriation . . . . . 3,000.00	Meters purchased . . . . . 1,379.50
	Interest . . . . . 115,535.00
	Balance on hand . . . . . 4,413.91
Total . . . . . \$171,757.43	\$171,757.43

## CONSUMPTION.

Estimated population to date.....	67,000
Estimated population supplied.....	65,000
Total number of gallons consumed for year.....	1,441,622,640
Total number of gallons metered.....	326,999,950
Average daily consumption in gallons.....	3,949,651
Gallons per day to each consumer.....	60
Gallons per day to each service.....	554

## DISTRIBUTION.

Kind of pipe used.....	Cast iron.
Size from 4 inches to 30 inches diameter.....	
Extended.....	10,813 feet.
Total now in use.....	429,245 feet.
Number of leaks for the year.....	12
Hydrants added.....	13
Hydrants now in use.....	773
Stop gates added.....	7
Stop gates now in use.....	538
Blow off gates.....	17
Fire service gates.....	23
Range of pressure at center for day and night.....	50 lbs. to 60 lbs.

## SERVICES.

Kind of pipe used.....	Lead and wrought iron
Size.....	$\frac{1}{2}$ inches to 3 inches.
Extended.....	8,527 feet.
Total now in use.....	52 miles 1,258 feet.
Service taps added.....	241
Service taps now in use.....	7,127
Meters added.....	40
Meters now in use.....	1,461

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FIFTEENTH  
ANNUAL REPORT  
OF THE  
LOWELL WATER BOARD,  
TO THE  
CITY COUNCIL,

AND BY THE REPORTS OF THE CITY ENGINEER,  
OF THE SUPERINTENDENT OF WATER WORKS,  
TO THE WATER BOARD.

JANUARY 10th, 1888.



LOWELL, MASS.:

THE NEWS COMPANY, PRINTERS, 16 MYRRHACK STREET,  
1888.





FIFTEENTH  
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LOWELL, MASS. :  
DAILY NEWS COMPANY, PRINTERS, 76 MERRIMACK STREET,  
1888.

**CITY OF LOWELL.**

IN WATER BOARD, January 10th, 1888.

**Read and accepted and ordered to be transmitted to the City Council.**

Attest : **HORACE H. KNAPP, Clerk.**

IN BOARD OF ALDERMEN, January 24th, 1888.

Ordered on file. Sent down.

GIRARD P. DADMAN, *City Clerk.*

IN COMMON COUNCIL, January 24th, 1888.

Received and ordered on file in concurrence.

DAVID CHASE, *Clerk.*

# CIVIL ORGANIZATION, LOWELL WATER WORKS.

From their Commencement to January 1, 1887.

## JOINT SPECIAL COMMITTEES.

1869.  
Jonathan P. Folsom, mayor.  
Charles A. Stott, alderman.  
Cyrus H. Latham, alderman.  
William H. Anderson, councilman.  
Frederic T. Greenhalge, councilman.  
Albert A. Haggett, councilman.  
Edwin Lamson, councilman.

1870.  
Jonathan P. Folsom, mayor.  
Charles A. Stott, alderman.  
Albert A. Haggett, councilman.  
Wm. Kittredge, councilman.  
Wm. O. Flake, councilman.

1871.  
Edward F. Sherman, mayor.  
Albert A. Haggett, alderman.  
Henry P. Perkins, councilman.  
Jeremiah Crowley, councilman.  
William Dobbins, councilman.

1872.  
Josiah G. Peabody, mayor.  
Alexander G. Cumnock, alderman.  
Henry P. Perkins, councilman.  
Nathaniel C. Sanborn, councilman.  
Crawford Burnham, councilman.

## WATER COMMISSIONERS.

1870-71-72.

Levi Sprague, chairman.  
Wm. K. Livingston.  
Henry H. Wilder, resigned Sept. 26, 1871.  
Samuel K. Hutchinson, elected to fill vacancy.

## WATER BOARD.

1873.  
Levi Sprague, president, from the citizens.  
William F. Salmon, from the citizens.  
Jonathan P. Folsom, alderman.  
Nathaniel C. Sanborn, councilman.  
Nathan W. Frye, councilman.

1874.  
Levi Sprague, president, from the citizens.  
William F. Salmon, from the citizens.  
Nathaniel C. Sanborn, alderman.  
Nathan W. Frye, councilman.  
G. W. S. Hurd, councilman.

1875.  
Geo. Runels, president, from the citizens, re-  
signed Nov. 9, 1875.  
Cyrus H. Latham, president pro tem., from the  
citizens.  
Benj. Walker, alderman.  
Albert A. Haggett, councilman.  
Earl A. Thissell, councilman.

1876.  
Cyrus H. Latham, president, from the citizens.  
Earl A. Thissell, from the citizens.  
Albert A. Haggett, alderman.  
Benj. C. Dean, councilman, resigned May, 1876.  
John F. Kimball, councilman, elected to fill  
vacancy.  
Orford R. Blood, councilman.

1877.  
Cyrus H. Latham, president, from the citizens.  
Albert A. Haggett, from the citizens.  
Horace R. Barker, alderman.  
John F. Kimball, councilman.  
James W. Bennett, councilman.

1878.  
Albert A. Haggett, president, from the citizens.  
James W. Bennett, from the citizens.  
Horace R. Barker, alderman.  
John F. Kimball, councilman.  
Charles H. Harvey, councilman.

1879.  
Albert A. Haggett, president, from the citizens.  
James W. Bennett, from the citizens.  
Horace R. Barker, alderman.  
Edward B. Pierce, councilman.  
Robert G. Bartlett, councilman.

1880.  
Albert A. Haggett, president, from the citizens.  
James W. Bennett, from the citizens.  
Robert Wood, alderman.  
Charles C. Hutchinson, councilman.  
Edward B. Pierce, councilman.

1881.

Albert A. Haggett, president, from the citizens.  
 James W. Bennett, from the citizens.  
 Robert Wood, alderman.  
 Charles C. Hutchinson, councilman.  
 Samuel Hosmer, councilman.

1882.

Albert A. Haggett, president, from the citizens.  
 Charles C. Hutchinson, from the citizens.  
 Thomas R. Garity, alderman.  
 William N. Osgood, councilman.  
 Frank Wood, councilman.

1883.

Albert A. Haggett, president, from the citizens.  
 Charles C. Hutchinson, from the citizens.  
 George W. Fifield, alderman.  
 Edward B. Pierce, councilman.  
 John J. Hogan, councilman.

1884.

Albert A. Haggett, president, from the citizens.  
 C. A. R. Dimon, from the citizens.  
 George W. Fifield, alderman.  
 Edward B. Pierce, councilman.  
 John J. Hogan, councilman.

1885.

Albert A. Haggett, president, from the citizens.  
 C. A. R. Dimon, from the citizens.  
 James Francis, alderman.  
 Alfred M. Chadwick, councilman.  
 Arnold S. Welch, councilman.

1886.

Walter Coburn, president, from the citizens.  
 C. A. R. Dimon, from the citizens.  
 James Francis, alderman.  
 Arnold S. Welch, councilman.  
 Frank W. Howe, councilman.

1887.

Walter Coburn, president, from the citizens.  
 C. A. R. Dimon, from the citizens.  
 James Francis, alderman.  
 Arnold S. Welch, councilman.  
 Frank W. Howe, councilman.

1888.

C. A. R. Dimon, president, from the citizens.  
 Miles F. Brennan, from the citizens.  
 Marcellus H. Fletcher, alderman.  
 John E. Drury, councilman.  
 Daniel J. Cleary, councilman.

*Investigations were made at various times, by order of the City Council, for the introduction of pure water into the city, viz. :  
By Joint Special Committee, consisting of the following named citizens :*

1828.

Oliver M. Whipple, alderman.  
George Brownell, alderman.  
Thomas Hopkinson, councilman.  
Benjamin Walker, councilman.  
David Dana, councilman.

1839.

Oliver M. Whipple, alderman.  
John Clark, alderman.  
Thomas Hopkinson, councilman.  
Benjamin Walker, councilman.  
John Nesmith, councilman.

1848.

Jefferson Bancroft, mayor.  
Oliver M. Whipple, alderman.  
David Dana, alderman.  
John Avery, councilman.  
Otis L. Allen, councilman.  
Thomas Hopkinson, councilman.  
Ignatius Tyler, councilman.

1865.

George W. Norris, alderman.  
Edward F. Watson, alderman.  
Charles W. Dodge, councilman.  
T. L. P. Lamson, councilman.  
John Pearson, councilman.

1866.

Josiah G. Abbott, mayor.  
Charles W. Dodge, alderman.  
Joseph L. Sargent, alderman.  
Benjamin Walker, councilman.  
Edward C. Rice, councilman.

## WATER BOARD, 1887.

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*President* - - - C. A. R. DIMON.  
Term expires first Monday in May, 1888.  
MILES F. BRENNAN.  
Term expires first Monday in May, 1889.  
Alderman MARCELLUS H. FLETCHER.  
Councilman JOHN E. DEURY. Councilman DANIEL J. CLEARY.  
*Clerk* - - - HORACE H. KNAPP.  
*Superintendent of Works* - - - Robert J. Thomas.  
*Foreman of Works* - - - Thomas Doyle  
*Engineer at Pumping Station* - - - Lewis Stiles.  
*Service Clerk* - - - Leonard T. Farris.


*Inspectors.*

John J. Bancroft. Thomas E. Lennon.  
Willard S. Knowlton. Julian L. Whiteside.

*Meter Inspector.*

ROBERT GARDNER.

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 The Water Office is open daily from 9 A. M. to 3 P. M., and on Monday evenings from 7 to 8 o'clock.

# REPORT OF THE WATER BOARD.

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OFFICE OF THE LOWELL WATER BOARD,  
LOWELL, MASS., Jan. 10, 1888.

*To the City Council of the City of Lowell:*

GENTLEMEN,—We have the honor to herewith present the Fifteenth Annual Report of the Lowell Water Board.

In every department of the works harmony and efficient honest service has prevailed, and we consider the condition of all branches to be excellent.

The surplus of moneys received, over all expenditures, for the year 1887 is \$5,384.59, and we can report the Water Works, for the first time in its history, self-sustaining, without appropriations from your honorable body, and with a considerable balance in its favor. Taking out the \$3,000 that was appropriated to the works by your board in 1886, there was a balance in its favor Jan. 1, 1887, of about one thousand dollars.

We have already recommended to the City Council a reduction of charges for the use of water, as follows: For a family of six persons, from \$6.00 to \$5.00, and that the minimum first charge for a meter be made \$10.00 in place of \$12.00 as now placed, and that the



charge for a first water-closet be \$3.00 instead of \$4.00 as now taxed.

This reduction if adopted, will, we think, decrease the net revenue of the works for the year 1888 about twelve thousand dollars; but, from the natural anticipated increase in receipts, as shown in the last two years (charges for 1886 being \$9,903.43 over 1885, and charges for 1887 being \$10,619.54 over 1886), and expected reduced expenditures for the coming year, we are of the opinion that not only can rates for use of water be safely reduced, but that imperative improvements that have already been laid out, looking to a much needed purification of our city water, can be made, and that there will still be a surplus of receipts over any known expenditures.

The needed and unusual expenses incurred in 1887, that the boards for some years to come will not have to meet, are as follows: 4,100 feet of the old, leaky, cement-lined 10 x 12-inch pipe, that has been in use for about twenty years, in portions of Middlesex street, Broadway and Central street, has been taken up and replaced by new 12-inch iron pipe, and, incidental to this improvement, has been the taking out of old-fashioned and defective fire hydrants, and replacing them with those of improved pattern; also, over one hundred  $\frac{3}{4}$ -inch service-pipe, replaced by lead pipes. These necessary permanent changes involved a cost of about eleven thousand dollars. Again, carrying out a contract made by a former board, a new street has been cut through on the north side of the main reser-

voir, and the old dwelling-house belonging to the city, that was located in an unsightly position, nearly in front of the reservoir and in the way of the new street, was moved back about two hundred yards, and put in perfect repair. A permanent watchman has been placed in charge of both reservoirs, and the grounds around the main reservoir have been put in presentable condition and kept so, with new iron seats on the reservoir bank and a drinking-fountain near the front gate. The reservoir gate-house has been repaired, and the reservoir and surroundings are now an ornament to the city, a source of pride to our citizens, and a pleasure to visitors in summer.

We would refer you to the able and complete reports of the Superintendent and the City Engineer, herewith annexed, for further details of the workings of the several departments.

Owing to the non-election of new members of the board, by the City Council, the old board held over, and the first meeting of the new board was not held until March 14, 1887. The board consisted of the following members: Walter Coburn, president, and C. A. R. Dimon, from the citizens, and Alderman M. H. Fletcher and Councilmen John E. Drury and Daniel J. Cleary, from the City Council.

#### ORGANIZATION.

The annual organization occurred on May 2, 1887. The board then was composed of Charles A. R. Dimon

and Miles F. Brennan, elected from the citizens, and the above-named members from the City Council.

The board organized by the choice of Charles A. R. Dimon as president, and Horace H. Knapp as clerk.

#### CONTRACTS.

The following contracts were awarded through the year, in each case to the lowest bidder;

March 14th, 10 tons of cast-iron pipe, 4-inch; 100 tons of cast-iron pipe, 6-inch; 10 tons of cast-iron pipe, 8-inch; to the Donaldson Iron Co., of Emeus, Pa., at \$34.50 per ton of 2000 pounds.

June 27th, 150 tons of cast-iron pipe, 12-inch; 10 tons of cast-iron pipe, 8-inch; to the Gloucester Iron Co., Gloucester, N. J., at \$35.00 per ton of 2240 pounds.

June 7th, 1000 tons of Elk Garden, Cumberland coal, to Lewis, S. Adams, of Lowell, Mass., at \$4.97 per ton of 2240 pounds, delivered at pumping-station.

#### STATISTICS AND MEMORANDA.

The amount of bills left over from 1886, for collection, was \$17,945.24, all of which have been settled.

The total charges for water-rates, for the year, have been \$184,395.24, against \$173,775.70 for the year 1886; an increase \$10,619.54. Of the charges from Jan. 1, 1887, to Sept. 1, 1887, amounting to \$145,011.27, all has been collected but \$554.14. The charges for the last

four months of 1887 amounted to \$39,383.97, all of which was not quite due at closing of the books. The number of water takers was about fifteen thousand.

The total amount of water pumped during the year was 1,578,992,610 U. S. gallons, an increase over the year 1886 of 137,369,970 U. S. gallons. The daily average was 4,326,007 U. S. gallons pumped into the low service, and 57,015 U. S. gallons pumped into the high service, reservoir, an increased daily average over the year 1886, in the low service, of 376,356 U. S. gallons.

1,467 $\frac{1}{2}$  tons of coal have been used during the year, 31 $\frac{5}{8}$  tons of which were used for the high service engine; 225 $\frac{1}{2}$  tons for the Worthington engine; 1210 $\frac{1}{2}$  tons for the Morris engine.

There have been 333 gallons of water raised 78.91 feet high for each pound of coal consumed by the high service engine, 425 gallons raised 163.70 feet high for each pound of coal consumed by the Worthington engine, and 573 gallons raised 162.82 feet high for each pound of coal consumed by the Morris engine.

The cost of pumping 1,000,000 gallons was \$6.65 in 1887, by the Morris engine, and \$7.89 in 1886, by the Worthington engine. With the cost of coal increased, the cost of pumping in 1887 has exceeded that of 1886, but the following table will show that with coal in 1887 at the same price as in 1886, the cost of pumping in 1887, then, has been decreased from that of 1886; and that there have been more gallons of water raised from one pound of coal than for some time, if ever before,

in the history of the water works; and that the remarkable results show conclusively the perfect condition of the pumping-station and able management of our engineer, Mr. Lewis S. Stiles.

#### MORRIS ENGINE.

Cost of pumping 1,000,000 gallons in 1887, with average price of coal \$4.31,—\$6.65.

Cost of pumping 1,000,000 gallons in 1887, with average price of coal \$3.92 (as paid in 1886), \$6.31.

Cost in 1886, \$6.52.

#### WORTHINGTON ENGINE.

Cost of pumping 1,000,000 gallons in 1887, with average price of coal \$4.29,—\$7.89.

Cost of pumping 1,000,000 gallons in 1887, with average price of coal \$3.87 (as paid in 1886), \$7.40.

Cost in 1886, \$7.53.

#### PRICES OF COAL.

In 1886, 1035 tons of coal, out of 1100 tons in all, were bought at \$3.72 and \$4.15 per ton of 2000 pounds, and a small quantity at \$4.65 per ton of 2240 pounds; while in 1887, 1000 tons were bought at \$4.97 per ton of 2240 pounds, or an average of \$4.43 $\frac{1}{2}$  per ton of 2000 pounds, making a total difference of about four hundred and seventy dollars more for coal this year than last.



# CHARGES FOR WATER BY MONTHS, FROM COMMENCEMENT TO DECEMBER 31, 1887.

MONTHS.	1872.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.
January,	-----	\$ 363 94	\$ 418 96	\$ 150 45	\$ 126 51	\$ 169 14	\$ 262 44	\$ 233 73	\$ 182 58	\$ 233 37	\$ 271 52	\$ 472 76	\$ 702 05	\$ 410 21	427 66
February,	-----	36 93	235 43	238 85	86 64	144 38	238 10	349 08	146 40	139 22	136 06	347 66	362 90	439 68	439 98
March,	\$6,124 94	50,200 10	65,417 68	82,249 51	89,177 68	82,226 43	80,603 69	80,567 44	80 210 68	90,856 37	94 956 65	96,692 13	102,961 30	104,537 77	111,281 68
April,	783 89	1,739 50	935 20	265 34	584 11	1,970 12	9,242 64	0,478 39	540 20	403 64	263 10	351 78	439 64	1,365 01	773 67
May,	2,988 16	3,274 09	2,147 96	874 47	1,819 65	1,121 43	2,761 35	1,476 15	879 61	1,191 41	984 84	1,496 90	1,492 34	1,760 48	2,087 80
June,	5,818 78	2,865 86	2,887 43	4,460 91	2,389 62	3,908 60	6,126 86	868 08	12,574 12	16,401 62	17,757 44	18,769 27	21,203 61	23,768 43	22,017 00
July,	4,833 62	1,889 03	1,926 31	582 68	3,147 78	1,261 24	1,213 13	11,457 84	273 00	969 80	1,069 37	999 21	1,063 36	1,434 99	2,383 37
August,	2,728 30	408 50	449 86	771 87	709 68	677 01	563 36	469 17	514 40	634 40	902 76	984 17	828 40	1,173 44	927 65
September,	2,827 07	32,45 06	865 90	496 97	3,493 90	4,998 07	6,564 86	8,108 23	10,068 19	10,904 30	12,467 32	12,939 94	13,462 97	16,106 06	18,397 55
October	\$,729 05	872 10	2,947 93	4,893 44	543 79	663 80	464 29	338 51	309 22	562 27	941 81	738 12	697 87	783 29	1,108 16
November,	701 21	634 03	573 36	1,445 66	518 72	1,220 27	1 406 89	620 56	873 16	378 97	1,615 65	693 41	477 10	686 02	683 55
December,	1,571 72	3,689 79	3,665 69	3,246 39	4,040 71	4,622 75	5,794 77	7,361 52	9 693 32	10,646 04	12,512 70	12,544 56	12,617 45	12,825 41	15,927 35
Total,	\$39 168 64	\$69,307 39	\$82,861 60	\$99,574 93	\$98,178 93	\$102,877 32	\$115,261 20	\$118,608 70	\$125,976 27	\$133 503 46	\$143 84 9 22	\$146,028 85	\$155,848 98	\$165,279 78	\$177,425 51
Less a b a t e - ments to date	-----	1,872 83	640 06	8,185 88	2,502 66	4,343 13	9 590 06	1,702 13	3,766 98	2,450 50	3,094 15	4,314 79	3,946 34	2,901 18	2 387 70
Net amount,	\$39,168 64	\$67,434 56	\$82,221 54	\$91 489 05	\$95 676 28	\$98,534 19	\$106,671 15	\$117,106 58	\$122 208 30	\$131,012 95	\$140,775 07	\$144,614 06	\$151,902 64	\$162,288 60	\$175,067 81

## FINANCIAL STATEMENT.

The total gross amount of bills sent to the City Treasurer for collection, from this department, for the year, ending Dec. 31, 1887, is as follows:

For Water-rates.....	\$101,398 15	
Metered water.....	75,027 36	
Total for the use of water ..		\$176,425 51
For Service pipe and laying..	\$2,589 74	
Meters sold .....	2,593 60	
Sundry accounts.....	2,786 39	
		7,969 73
Total charges for the year.....		\$184,395 24

The following statement exhibits the receipts and expenditures for the year, the net cost of the Water Works, including the interest on the Water Loan, and all expenses in excess of receipts for water-rates; also the total net cost and expenses in excess of receipts for water rates; also the total net cost and expenses in excess of receipts and expenses of the works by taxation.

Net cost of Water Works to Jan. 1, 1887.....	\$2,384,572 31
Expended during the year, for water-pipes and for laying the same, and all other items of	

## CONSTRUCTION.

## MATERIALS FOR MAINS, SERVICES, ETC.,—

Cast-iron pipe.....	\$9,363 22	
Cast-iron pipe specials.....	217 93	
Wrought-iron pipe and fittings .....	804 03	
Lead pipe.....	2,754 36	
<i>Amounts carried forward.....</i>	\$13,139 54	\$2,384,572 31

<i>Amounts brought forward</i> .....	\$13,139 54	\$2,384,572 31
Lead .....	931 67	
Hardware .....	21 57	
Teaming pipe.....	185 46	
Supplies .....	110 27	
Freight .....	807 19	
Wood.....	8 00	
Water-gates .....	244 84	
Sidewalk-cocks .....	441 75	
Kyanized plank .....	47 07	
Brass castings .....	36 79	
Sidewalk-boxes .....	816 94	
Cellar-cocks .....	441 25	
Dualin and exploders.....	37 33	
Corporation cocks .....	416 92	
Clay pipe .....	73 32	
Hydrants.....	186 96	
Hydrant-boxes .....	154 40	
Hydrant repairing .	21 40	
Hydrant freight .....	2 05	
Hydrant cases.....	94 38	
	<hr/>	
	\$18,219 10	

## LABOR, PAY-ROLL,—

Extensions .....	\$4,845 71	
Services .....	3,366 97	
	<hr/>	
	8,212 68	
	<hr/>	
Total construction account.....	\$26,431 78	

## MAINTENANCE.

EXPENDED FOR CURRENT EXPENSES, REPAIRS, PUMP-  
ING, ETC., VIZ :

## OFFICE, PIPE YARD, STABLES, ETC.

Printing 1886 Report.....	\$ 78 00	
Paper, ink, pens, etc.....	216 87	
Horse-car tickets .....	22 00	

<i>Amounts carried forward</i> .....	\$316 87	\$2,384,572 31
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<i>Amounts brought forward</i> .....	\$ 316 87	\$2,384,572 31
Curtains .....	50 00	
Telephone .....	266 73	
Printing books, bills, etc.....	226 26	
Postage stamps.....	21 25	
Cleaning office, pay-roll.....	48 88	
Screen door .....	12 60	
Insurance .....	25 00	
Engineering .....	292 69	
Sundries .....	218 37	
Rubber boots .....	36 10	
Oats, corn, hay, etc.....	223 82	
Repairs of wagons, harnesses, etc.....	77 55	
Medical attendance — horses.....	14 00	
Horse shoeing.....	69 06	
Sundries .....	65 87	
Flushing sewers.....	90 00	
Horse and wagon.....	435 00	
Harnesses.....	115 00	
Hose .....	300 00	
Water damage, 1886, (execution)....	462 71	
President water board.....	400 00	
Superintendent water works.....	1,600 00	
Clerks in office, pay roll. ....	3,068 14	
Foreman, pay roll.....	1,044 32	
Inspectors, pay roll .....	3,908 01	
 Total current expenses.....	 \$13,388 23	

## REPAIRS.

Tools.....	\$ 21 41
Tools, repairing.....	12 82
Coal.....	17 50
Tin, pig.....	29 00
Gravel.....	5 25
Hardware .....	253 78
Lumber.....	99 30
Wood.....	12 00
Teaming.....	35 75

<i>Amounts carried forward</i> .....	\$486 81	\$2,384,572 31
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# REPORT OF THE WATER BOARD.

17

<i>Amounts brought forward</i> .....	\$ 486 81	\$2,384,572 31
Sundries.....	93 78	
Labor, pay roll.....	4,105 89	
	<hr/>	
Total repairs.....	\$4,686 48	
	<hr/>	

## PUMPING ACCOUNT.

Iron casting.....	\$ 27 10	
Gas .....	178 52	
Oil.....	201 73	
Packing.....	26 24	
Belting.....	15 54	
Steel.....	7 75	
Coal.....	5,248 58	
Examination of engine.....	140 00	
Sundries.....	76 33	
Waste.....	35 00	
Labor, pay roll.....	4,110 14	
	<hr/>	
Total pumping account.....	\$10,066 93	
	<hr/>	

## METER ACCOUNT.

Meters purchased.....	\$2,276 99	
Drawing sketches.....	\$ 76 33	
Freight.....	6 73	
Repairs on meters.....	202 72	
Brass castings.....	63 49	
Hardware.....	3 42	
Second hand meter..	10 00	
Labor, pay roll.....	2,254 50	
	<hr/>	
	2,617 19	
	<hr/>	
Total meter account.....	\$4,894 18	
	<hr/>	

## RESERVOIR, BEACON STREET.

Repairing house.....	\$312 96	
Iron stairs.....	300 00	
	<hr/>	
<i>Amounts carried forward</i> .....	\$612 96	\$2,384,572 31

<i>Amounts brought forward</i> .....	\$	612 96	\$2,384,572 31
Teaming.....		22 00	
Oil.....		100 84	
Doors.....		2 60	
Paint.....		40 90	
Concrete.....		61 74	
Repairing screen.....		36 40	
Stone, 1886, (execution).....		179 52	
Sundries.....		107 56	
Lumber.....		101 88	
Brick and lime.....		14 50	
Moving house.....		391 00	
Plastering.....		47 30	
Labor, pay roll.....		1,049 25	
Total reservoir account.....			<u>\$2,768 45</u>

## RECAPITULATION.

Total construction.....	\$26,431 78	
Total current expenses....	\$12,388 23	
Total repairs.....	4,686 48	
Total pumping.....	10,066 93	
Total meter.....	2,617 19	
Total reservoir.....	2,768 45	
Total maintenance account.....	33,527 28	
Meters purchased.....	2,276 99	
Amount expended for the year, exclusive of interest.....	\$62,236 05	
Interest paid during the year.....	110,790 00	
Note paid.....	3,000 00	
Amount refunded vacancies, 1887.....	880 00	
Total expenditures for the year.....	176,906 05	
		<u>\$2,561,478 36</u>
<i>Amount carried forward</i> .....		\$2,561,478 36

*Amount brought forward* ..... \$2,561,478 36

## CREDITS.

Amounts received by the City Treasurer during the  
year, for water rates, service pipes and sundries,  
viz :

For account of 1883.....	\$	8	10
For account of 1884.....		30	95
For account of 1885.....		122	29
For account of 1886....		18,177	85
For account of 1887.....		159,895	10

Total receipts for the year.....		\$178,234	29
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Net cost of works, including interest on Water Loan to Jan. 1, 1888.....		\$2,383,244	07
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Present debt of the city, by bonds and notes, on account of construction of Water Works.....		1,834,000	00
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Total amount paid from the City Treas- ury to Jan. 1, 1888, by taxation, on account of Water Works, in excess of receipts from loans and water rates.....		549,244	07
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Value of Water Works Sinking Fund, Jan. 1, 1888. ....		570,250	10
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\$1,119,494 17

Net cost of Works, including interest on Water Loan, to Jan. 1, 1888.....		\$2,383,244	07
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Whole amount paid by taxation, and by appropriation for the Sinking Funds, and the value of said funds, Jan. 1, 1888 .....		1,119,494	17
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Debt of the city on account of Water Works, in excess of Water Works Sinking Funds, Jan. 1, 1888.....		\$1,263,749	90
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The following table will show the gross cost of the Water Works yearly, from the commencement of the same, to Jan. 1, 1888:

Expended in 1870.....	\$ 95,057 00
" 1871.....	624,151 66
" 1872.....	560,708 40
" 1873.....	349,717 87
" 1874.....	233,370 63
" 1875.....	275,660 78
" 1876.....	221,502 24
" 1877.....	163,814 28
" 1878.....	158,510 15
" 1879.....	150,047 82
" 1880.....	154,391 59
" 1881.....	231,171 27
" 1882.....	173,645 92
" 1883.....	180,280 28
" 1884.....	175,290 02
" 1885.....	176,972 56
" 1886.....	169,105 22
" 1887.....	176,906 05

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Gross cost of Works to Jan. 1, 1888.....	\$4,270,303 74
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Receipts from various sources to Jan. 1, 1888,	1,887,059 64
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Net cost of Works to Jan. 1, 1888.....	<u>\$2,383,244 10</u>
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The following table will show the expenditures and receipts of the Works from 1873 to 1888, exclusive of interest on the Water Debt:

	Expenditures.	Receipts.	Expenditures in excess of receipts.	Receipts in excess of expenditures.
1873	\$188,376 59	\$57,739 48	\$130,637 11	
1874	128,105 63	80,625 05	47,479 98	
1875	170,095 78	94,908 14	75,187 64	
1876	115,012 24	98,815 54	16,196 70	
1877	53,988 72	100,826 63		\$46,837 91
1878	49,900 15	104,142 87		54 242 72
1879	42,157 82	110,185 34		68,027 52
1880	45,031 59	123,740 49		78,708 90
*1881	121,601 27	128,053 97		6,452 70
†1882	64,525 92	140,397 96		75,872 04
1883	65,673 23	152,582 99		86,909 76
1884	64,982 71	154,437 55		89,454 84
‡1885	64,030 24	157,956 79		93,926 55
1886	51,808 52	168,757 53		116,949 01
\$1887	62,236 05	178,234 29		115,998 24

Taking into consideration the fact that Mr. Robert J. Thomas, as superintendent, and Mr. Lewis

\*In 1881 there were expended the following extraordinary amounts: For river crossing, 34-inch reserve line, \$9,988.59; for high service water supply, \$57,969.89.

†In 1882, high service water supply, \$10,896.59.

‡In 1885, Beacon street reservoir, \$14,766.27.

\$In 1887, changing cement pipe, Central, Broadway and Middlesex streets, \$10,488.74.

Had these extraordinary expenses not occurred, the excess of receipts over expenditures for those years would have been respectively \$74,410.68, \$86,770.63, \$108,692.62 and \$126,456.94.



Stiles, as engineer at pumping station, were new appointees of the board in 1887, without previous experience in the management of water works, the board are of the opinion that the present high state of efficiency in all departments of the works is a subject of especial congratulation, and would take this occasion to thank the above named gentlemen for their hearty co-operation with the board and for the intelligent, economical and laborious endeavor that has brought this branch of the city's interests up to the present satisfactory standard.

The duties of clerk of the board as performed by Mr. Horace H. Knapp have been ably and faithfully attended to, and his long association with and experience in water works matters renders his services valuable to the board and to the public.

The force of inspectors has been reduced by one, and in order that parties using water meters might have speedy notification of unusual quantity of water passing through meters, as also of any defect in the instrument, their duties have been increased by having the reading of meters taken once a month, in place of once a quarter, as formerly. They have performed their allotted duties in an able and satisfactory manner.

The continuous service of over sixteen years in the water works of Assistant Engineer Thomas McLaughlin, at pumping station, calls for especial notice by the board; as, to his conscientious and intelligent attention to his duty, is due, in a great

measure, the very successful years' operation of the engineers at the station.

#### CONDITION OF WATER SUPPLY.

While there is no doubt but that our water is as pure as that used in the majority of cities, yet the board have given the question of how to keep it up to the standard of the past, careful thought and watchful care.

We have had monthly reports of a chemical analysis of the water from the Merrimack river and do not feel that there is any cause for alarm in those reports at present, yet we feel it is imperative that some means should be taken at once to meet this growing impurity, either by a system of a new supply from some of the numerous surrounding spring water ponds, or by a more thorough plan of filtration, aeration, and settling basins of the present supply. Your board have already adopted a system of aeration in winter by running the water at the reservoir gate house over a plank platform about six feet wide and allowing it to fall in a broad, thin stream some seven feet into the reservoir, and also have had in contemplation the erecting of stand pipes short distances apart, connecting with and over the conduit which runs from the inlet wells on Merrimack river to the pumping station, thus taking off any foul air that may collect in that long pipe.

As you are perhaps aware, there is now a filtering basin some 1,400 feet long on the up river side



of the inlet wells, which (as explained in superintendent's report) is partly inoperative, and even if in good operation could only supply about one-fourth of our daily consumption of filtered water and then would mix (by present arrangements) with the three-fourths water unfiltered running from the river through screens to inlet wells. The board has paid particular attention to the proper screening of water at numerous points and the thorough cleaning through the year of supply inlets, but would again strongly recommend that more extensive measures be used to purify the waters—by pumping pure air into the reservoir supply, by a settling basin near that supply, and a new system of filtration.

In 1890 it is hoped that our water debt can be refunded at a much lower rate of interest, when a greater income and surplus for needed improvements in the above mentioned direction will be available, and a still further reduction of rates may be reasonably expected by the citizens.

It has been the aim of your board to look upon the water assessment as a tax upon our citizens that should be made as light as possible, and that at an early date as consistent water should be given free, at least to private families.

Respectfully submitted.

CHAS. A. R. DIMON,  
MARCELLUS H. FLETCHER,  
MILES F. BRENNAN,  
DANIEL CLEARY,  
JNO. E. DRURY.

# SUMMARY OF STATISTICS.

REPORT OF 1887.

IN ACCORDANCE OF SUGGESTIONS ADOPTED BY THE NEW ENGLAND  
WATER WORKS ASSOCIATION.

## LOWELL WATER WORKS, LOWELL, MASS.

Population by census of 1885, 64,051.

Date of construction, 1870 to 1872 inclusive.

Owned by the City of Lowell.

The source of supply is from the Merrinack River.

The mode of supply is by pumping, and consists of one Morris pump and one Worthington pump of 5,000,000 gallons daily capacity each.

The kind of coal used is Elk Garden, Cumberland.

Cost of coal is \$4.97 per ton of 2240 pounds.

	MORRIS.	WORTHINGTON.
Coal consumed for the year in lbs.	2,421,350	451,300
Total pumping in gallons.....	1,387,277,760	191,714,850
Average head, including friction, in feet. ....	162.52	163.79
No. of gallons pumped per lbs. of coal.....	573	425
Duty on total coal consumed, no deduction for anything.....	77,600,802	57,987,101
Cost of pumping, figured on pump- ing station expenses.....	\$9,216.57	\$1,513.41
Per million gallons into reservoir..	\$6.65	\$7.89
Per million gallons one foot pipe. .	.04 $\frac{1}{10}$	.04 $\frac{8}{100}$

### CONSUMPTION.

Estimated population to date, 70,000.

Estimated population supplied, 68,000.

Total number of gallons consumed for year, 1,576,495,007.

Total number of gallons metered, 352,338,750.  
 Average daily consumption in gallons, 4,319,164.  
 Gallons per day to each consumer, 63.  
 Gallons per day to each service, 580.

## DISTRIBUTION.

Kind of pipe used, cast iron.  
 Size, from 4 inches to 30 inches in diameter.  
 Extended in 1887, 9,116 feet.  
 Total now in use, 438,351 feet.  
 Number of leaks for the year, 15.  
 Hydrants added, 7.  
 Hydrants now in use, 779.  
 Stop gates added, 14.  
 Stop gates now in use, 552.  
 Blow off gates, 17.  
 Fire service gates, 26.  
 Range of pressure at centre for day and night, 50 to 60 pounds.

## SERVICES.

Kind of pipe used, lead and wrought iron.  
 Size,  $\frac{5}{8}$  inch to 3 inches.  
 Extended, 8,527 feet.  
 Total now in use, 54 miles, 2,654 feet.  
 Service taps added, 321.  
 Service taps now in use, 7,440.  
 Meters added, 83.  
 Meters now in use, 1,530.

## FINANCIAL.

RECEIPTS.	EXPENDITURES.
Balance Jan. 1, 1888..... \$ 4,036 38	Construction ..... \$ 26,431 78
Water rates and services..... 107,766 48	Maintenance ..... 33,527 28
Metered water..... 70,467 81	Meters purchased..... 2,276 99
	Interest..... 110,790 00
	Note ..... 3,000 00
	Refunds ..... 886 00
	Balance Jan 1, 1888..... 5,384 59
	Difference Treasurer's account 03
<hr/> \$182,200 67	<hr/> \$182,200 67

FIFTEENTH ANNUAL REPORT

OF THE

Engineer, to the Water Board.

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JANUARY 1, 1888,

## SUMMARY OF STATISTICS.

Total number of gallons metered, 352,338,750.

Average daily consumption in gallons, 4,319,164.

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—  
Balanc  
Water  
Meter

\$182,290 67

\$182,290 67

FIFTEENTH ANNUAL REPORT

OF THE

City Engineer, to the Water Board.

-----  
JANUARY 1, 1888,



# REPORT OF THE ENGINEER.

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OFFICE OF CITY ENGINEER,

LOWELL, MASS., Jan. 2, 1888.

*To the Lowell Water Board:*

GENTLEMEN—The following is the Fifteenth Annual Report of the work done by the pumping engines of the Lowell Water Works:

The calculations of the duty of the engines were made from the records kept by the engineers in charge, Mr. James P. Roberts from Jan. 1, to March 22, 1887, and Mr. Lewis Stiles from March 22 to Jan. 1, 1888.

All the coal used at the pumping station has been charged to pumping, no deduction of any kind having been made for heating the building or running the small stationary engine used to furnish the power for the machine shop.

All repairs on the engines and boilers have been done by the engineers in charge and their assistants.

The average cost of pumping one million gallons from the Low Service Reservoir to the High Service Reservoir is eight dollars and seventy-seven cents.



Table Showing Work Done with Morris Engine (Beam and Fly Wheel) and Boilers for each Month During the Year 1897.

MONTHS.	No. of days pump- ing.	Av'e No. of hours pumping per day.	Number of hours pumping per month.	Number of strokes made per month.	Average No. of strokes made per minute.	Average head including friction in feet.	Quantity pumped per month in U. S. gallons.	Av range pumped per day in U. S. gallons.	No. gal. of water raised in reservoir per day of total coal consumed.	Duty in lbs., 100 lbs. coal, used in pumping only, no deduction for ashes or clinkers.	Duty on total coal consumed, no deduction for ashes or clinkers.
January - - - -	27	21-47	588-00	443,579	12.57	165.09	141,945,280	5,257,233	571.	93,443,469	78,495,519
February - - - -	24	22-26	538-15	408,226	12.64	163.48	130,632,320	5,443,013	575.	93,476,367	78,335,826
March - - - -	25	20-41	517-10	401,021	12.92	163.38	128,326,720	5,133,069	582.	94,730,723	79,189,132
April - - - -	21	17-47	373-20	285,988	12.77	162.48	91,516,160	4,357,912	558.	90,125,660	75,516,626
May - - - -	17	19-58	339-30	260,490	12.79	161.88	83,356,800	4,903,341	571.	91,952,013	76,972,850
June - - - -	26	20-37	536-15	407,248	12.66	162.38	130,319,360	5,012,283	583.	94,817,485	78,880,351
July - - - -	20	22-13	444-15	342,171	12.84	162.08	109,494,720	5,474,736	562.	90,074,712	75,925,402
August - - - -	23	20-53	480-15	363,553	12.62	161.88	116,336,960	5,058,129	575.	93,090,815	77,545,023
September - - -	22	19-49	436-00	332,151	12.70	162.58	106,288,320	4,831,287	564.	91,090,735	76,400,237
October - - - -	26	18-37	484-00	367,735	12.66	162.08	117,675,200	4,525,969	582.	94,333,934	78,572,761
November - - -	20	18-55	378-15	291,195	12.83	161.78	93,182,400	4,659,120	569.	91,504,336	76,653,711
December - - -	27	20-47	561-00	431,886	12.83	161.18	138,203,520	5,118,649	578.	92,591,125	77,708,355
Totals and Averages.	278	20-25	5,676-15	4,335,243	12.73	162.52	1,387,277,760	4,990,908	573.	92,700,221	77,600,802

Table Showing Work Done with Worthington Duplex Engine for each Month During the Year 1887.

MONTHS.	No. of days pumping.	Ave. No. of hours pumping per day.	Number of hours pumping per month.	Number of strokes made per month.	Average No. of strokes made per minute.	Average head including friction in feet.	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. gallons.	No. gal. of water raised in reservoir only, no deduction for coal consumed.	Duty in lbs., 1 foot high, with 100 lbs. coal, used in pumping only, no deduction for coal consumed.	Duty on total coal consumed, no deduction for ashes or clinkers.
January - - -	9	19-49	178-25	89 141	8.33	168.05	27,633,710	3,070,412	439.	70,366,921	61,431,439
February - - -											
March - - -	3	10-50	32-30	22,870	11.73	162.71	7,089,700	2,363,235	430.	69,164,111	58,265,527
April - - -	5	19-00	95-00	74,862	13.13	162.95	23,207,220	4,641,444	431.	66,771,171	58,579,973
May - - -	9	19-40	177-00	139,443	13.13	163.61	43,227,330	4,803,037	437.	68,061,859	59,536,944
June - - -											
July - - -	7	19-04	133-30	96,331	12.03	163.29	29,862,610	4,266,087	408.	63,998,109	55,441,736
August - - -	4	21-00	84-00	62,113	12.32	163.08	19,255,030	4,813,757	422.	65,424,194	57,389,650
September - - -	5	18-36	93-00	66,290	11.88	163.34	20,549,900	4,109,980	425.	67,084,108	57,917,345
October - - -											
November - - -	5	17-03	85-15	67,385	13.17	163.27	20,889,350	4,177,870	403.	61,523,744	54,872,729
December - - -											
Totals and Averages.	47	18-42	878-40	618,435	11.73	163.79	191,714,850	4,079,039	425.	66,403,394	57,987,101

Table Showing Amount of Coal Used for Morris Engine at Pumping Station  
During the Year 1887.

MONTHS.	COAL CONSUMED			
	For starting fires in lbs.	When pump- ing in lbs.	For bank'g fires in lbs.	Total per month in lbs.
January . . . . .	29,400	209,000	10,400	248,800
February . . . . .	27,000	190,400	9,800	227,200
March . . . . .	26,400	184,450	9,800	220,650
April . . . . .	19,200	137,500	7,400	164,100
May . . . . .	17,400	122,300	6,400	146,100
June . . . . .	27,600	186,100	10,000	223,700
July . . . . .	22,800	164,200	7,800	194,800
August . . . . .	24,600	168,600	9,200	202,400
September . . . . .	22,200	158,100	8,200	188,500
October . . . . .	24,600	168,500	9,200	202,300
November . . . . .	19,200	137,300	7,400	163,900
December . . . . .	28,200	200,500	10,200	238,900
Totals . . . . .	288,600	2,026,950	105,800	2,421,350

Table Showing Amount of Coal Used for Worthington Duplex Engine at  
Pumping Station During the Year 1887.

MONTHS.	COAL CONSUMED			
	For starting fires in lbs.	When pump- ing in lbs.	For bank'g fires in lbs.	Total per month in lbs.
January . . . . .	4,800	55,000	3,200	63,000
February . . . . .				
March . . . . .	1,800	13,900	800	16,500
April . . . . .	4,800	47,200	1,800	53,800
May . . . . .	9,000	86,600	3,400	99,000
June . . . . .				
July . . . . .	7,200	63,500	2,600	73,300
August . . . . .	4,200	40,000	1,400	45,600
September . . . . .	4,800	41,700	1,800	48,200
October . . . . .				
November . . . . .	4,200	46,200	1,400	51,800
December . . . . .				
Totals . . . . .	40,800	394,100	16,400	451,300

Table Showing Work Done with Worthington High Service Engine for each Month During the Year 1887.

MONTHS	No. of days pump- ing.	Avg. No. of hours pump- ing per day.	Number of hours pumping per month.	Number of strokes made per month.	Average No. of strokes made per minute.	Average head including friction in feet.	Quantity pumped per month in U. S. gallons.	Average quantity pumped per day in U. S. gallons.	No. gal. of water pumped (of coal consumed).	Coal in lbs. used when pumping.
January - - -	4	15-57	63-50	123,816	32.33	78.67	1,733,424	433,356	333.	5,210
February - - -	4	11-22	45-30	112,182	41.09	78.67	1,570,548	392,637	346.	4,540
March - - -	4	10-30	42-00	96,426	38.26	78.09	1,349,964	337,491	321.	4,200
April - - -	5	11-06	55-30	121,603	36.52	78.67	1,702,442	340,488	334.	5,100
May - - -	4	12-30	50-00	114,389	38.13	78.95	1,601,446	400,361	320.	5,000
June - - -	5	13-09	65-15	149,810	37.98	78.44	2,097,340	419,468	375.	5,600
July - - -	5	14-03	70-15	148,739	35.29	78.67	2,082,346	416,469	306.	6,800
August - - -	4	12-45	51-00	110,818	36.22	79.82	1,551,452	387,863	317.	4,900
September - - -	5	14-12	71-00	142,617	33.48	78.90	1,996,638	399,327	322.	6,200
October - - -	4	12-07	48-30	113,615	39.04	78.67	1,590,610	397,652	346.	4,600
November - - -	4	11-00	44-00	96,479	36.55	79.52	1,350,706	337,676	322.	4,200
December - - -	6	12-00	72-00	155,963	36.10	79.82	2,183,482	363,914	352.	6,200
Totals and Averages..	54	12-35	679-20	1,486,457	36.47	78.91	20,810,398	385,378	333.	62,550



## PUMPING STATION, MORRIS ENGINE.

## RUNNING EXPENSES FOR THE YEAR 1887.

Pay of engineers and firemen.....	\$3,575 96
578 $\frac{3}{10}$ tons coal (George's Creek, 1886-'87) at \$4.152 .	2,403 16
19 $\frac{7}{10}$ tons coal (Cumberland, 1887) at \$4.91.....	95 17
612 $\frac{1}{10}$ tons coal (Elk Garden, 1887) at \$4.43 $\frac{1}{2}$ .....	2,717 97
1 cord of wood.....	3 75
Gas for lighting works.....	136 72
60 pounds tallow, at 4 $\frac{1}{2}$ cents.....	2 70
176 gallons cylinder oil, at 47 $\frac{9}{10}$ cents.....	84 37
58.6 gallons lard oil, at 55 $\frac{9}{10}$ cents.....	32 77
10.0 gallons W. Va. black oil, at 30 cents.....	3 00
143 pounds cotton waste, at 11 $\frac{7}{10}$ cents.....	16 84
61 $\frac{1}{2}$ pounds soapstone packing, at 30 cents.....	18 45
3 pounds hemp packing, at 35 cents.....	1 05
3 $\frac{1}{2}$ pounds Jenkins packing, at 70 cents.....	2 45
Repairs on engine.....	56 93
Repairs on boilers.....	2 40
Tools and stock.....	28 73
Sundries.....	34 15

Total .....	<u>\$9,216 57</u>
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Cost of raising water into reservoir, per million gallons..	\$6 65
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Cost of raising water one foot high, per million gallons..	.04 $\frac{13}{100}$
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## WORTHINGTON ENGINE.

## RUNNING EXPENSES FOR THE YEAR 1887.

Pay of engineers and firemen.....	\$ 494 18
116 $\frac{3}{10}$ tons coal (George's Creek, 1886-'87) at \$4.152..	482 25
109 $\frac{1}{10}$ tons coal (Elk Garden, 1887) at \$4.43 $\frac{1}{2}$ .....	485 91
$\frac{1}{2}$ cord of wood, at \$3.75.....	1 87
Gas for lighting works .....	18 94
24 $\frac{1}{2}$ gallons cylinder oil, at 47 $\frac{9}{10}$ cents.....	11 74
8 gallons lard oil, at 55 $\frac{9}{10}$ cents.....	4 47
20 pounds cotton waste, at 11 $\frac{7}{10}$ cents.....	2 36

Amount carried forward .....	<u>\$1,501 72</u>
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<i>Amount brought forward</i> .....	\$1,501 72
8½ pounds soapstone packing, at 30 cents.....	2 55
Tools and stock.....	4 41
Sundries.....	4 73
<b>Total</b> .....	<b>\$1,513 41</b>

Cost of raising water into reservoir, per million gallons.	\$7 89
Cost of raising water one foot high, per million gallons..	.04 <sup>8</sup> / <sub>100</sub>

## RESERVOIR, BEACON STREET, 1887.

MONTHS.	Depth in feet.	Quantity in U. S. gallons.	Temperature in degrees.	
			Of water.	Of air.
January.....	17.81	26,872,127	32.17	23.87
February.....	18.42	27,877,323	32.58	29.62
March.....	17.49	26,338,141	32.33	31.95
April.....	18.18	27,477,112	39.69	45.26
May.....	18.25	27,587,388	57.01	64.00
June.....	18.56	28,112,484	66.88	69.74
July.....	18.50	28,001,761	75.55	78.66
August.....	18.75	28,417,395	72.61	70.08
September.....	18.91	28,696,576	64.68	60.74
October.....	19.09	28,984,687	54.27	49.76
November.....	19.14	29,064,137	42.08	39.60
December.....	19.03	28,880,241	35.35	29.59

Table showing the average monthly and daily consumption of water for the year 1887.

MONTHS.	Gallons per month.	Gallons per day.
January. ....	169,578,990	5,470,290
February. ....	133,354,443	4,762,659
March. ....	132,556,731	4,276,024
April. ....	111,238,678	3,707,956
May. ....	130,892,139	4,222,327
June. ....	129,016,393	4,300,546
July. ....	140,183,983	4,522,064
August. ....	133,933,649	4,320,440
September. ....	126,001,480	4,200,049
October. ....	120,718,595	3,894,148
November. ....	110,186,549	3,672,885
December. ....	138,905,377	4,480,818
Total and average. ....	1,576,495,007	4,319,164

#### WATER ANALYSIS.

About the middle of each month, beginning with June, samples of water have been taken from the following places: Centre of Merrimack river, opposite the inlet chamber; inlet chamber; Bodwell gate house, and the gate house at the Beacon street reservoir, where the water flows into the pipes for city distribution. These samples have been analyzed by the State Board of Health, and if this analysis is continued through a whole year it will give reliable data to judge of the standing of the Merrimack river as a water supply.

Respectfully submitted.

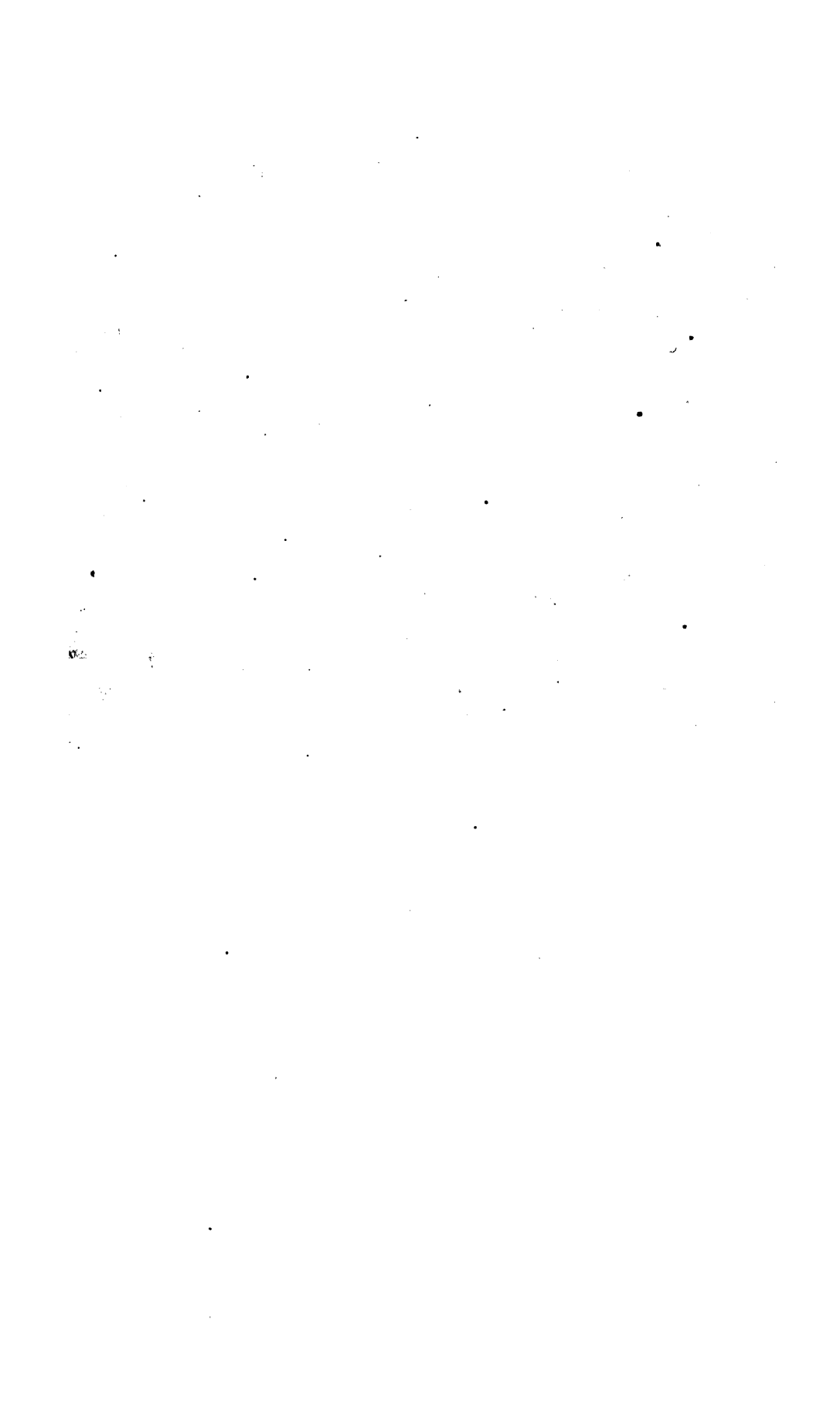
GEO. BOWERS, *City Engineer.*

FIFTEENTH ANNUAL REPORT  
OF THE  
Superintendent, to the Water Board.

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JANUARY 10, 1888.





# REPORT OF SUPERINTENDENT.

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SUPERINTENDENT'S OFFICE, CITY HALL,  
LOWELL, Jan. 2, 1888.

## *To the Lowell Water Board:*

GENTLEMEN—I have the honor of presenting to you, in accordance with a provision of the city ordinances, the Fifteenth Annual Report of the Superintendent of the Lowell Water Works for the year ending December 31, 1887, and in doing so it gives me great pleasure to be able to report that the department is at last self-sustaining, and that notwithstanding the extraordinary amount of work done this year we still have a large balance left.

### FILTER INLET, GALLERY AND CONDUIT.

The filter gallery and conduit are in good condition, no repairs having been necessary the past year. The filter inlet, so called, where it was intended to have the water come from the river into and through a filter bed of fine sand and gravel, thence into the gallery, is at present, and has been for years, practically of no use. This is owing to the fact that there is no barrier to the high water in the river overflowing and washing silt mud and other matter into the basin, thereby preventing the water from filtering through. This probably can be remedied

by erecting a wall on the river side of the basin and laying a large pipe from the filter out into the river and controlling it by a gate. That this should be done, or something looking to an increase in the percentage of filtered water, is apparent, when we consider that fully four-fifths of the water pumped is supplied directly from the river without undergoing any process of filtration or purification.

#### PUMPING STATION.

No repairs have been made at the pumping station this year, with the exception of a new iron ladder, which was put in the well of the Morris engine to take the place of a wooden ladder, which became unsafe. The only repairs made on the engines was the setting of three new rubber valves in the condenser of the Morris engine, and one new rubber valve in the main pump of the same engine. The total amount of water pumped into the reservoir this year was 1,578,992,600 gallons, an increase of 137,369,960 gallons over last year, which is 4,486,400 gallons less than the corresponding increase in 1886—equal to about one day's consumption. The high service engine has pumped this year 20,810,398 gallons, an increase of 557,676 gallons over last year, which is a smaller increase by 1,303,008 gallons than for 1886.

#### RESERVOIRS.

The moving of the buildings at the reservoir in consequence of the water board giving a part of the land for a street, necessitated considerable grading around the present location, also the filling of the old cellars. A six-inch pipe sewer 400 feet long was also laid from the present location of the house to connect with a six-inch

sewer in the driveway. In pursuance of a vote of the board I had twelve settees placed at different points around the reservoir. We also set a drinking fountain inside the entrance at the head of Beacon street for the accommodation of visitors. When cleaning the screens situated in the efflux chamber at the gate house where the water comes into the city, we found the planks which set on the top of the screens to be rotted to such an extent that fish and other matter was liable to pass through into the pipes. These were replaced by new planks, and a new set of screens ought to be built to have in readiness to replace the old ones the next time they are cleaned, as they are also in a bad condition. No improvements have been made at the high service reservoir.

#### EXTENSIONS.

During the past year the cast iron main pipe has been extended 9,116 feet, which is 1,687 feet less than was laid last year. Of the amount laid this year 876 feet was laid on the high service line. The prospect for next year is that the demand for extension will not be as great as this year. Complete figures of the size and location of the pipe laid this year have been made by Mr. Foster of the engineer's office, and accompany this report.

#### RELAYING MAIN PIPE.

For a number of years back the cement lines of pipe in use in the city, situated on Central, Broadway and Middlesex streets, had become in such an unsafe condition that they were liable to burst at any time, and it was thought impracticable to tap them for service pipes.

The hydrants on them were also small old-fashioned and inadequate for a sufficient water supply in case of a large fire in any of the streets where they were located. In consideration of these facts, and owing to the prospect of having a large surplus to our credit at the close of the year—it being too late in the year to reduce the rates—it was thought advisable to take up all the cement pipe in the city. Accordingly the whole amount, about 4,100 feet, was taken up and replaced by twelve-inch cast iron pipe. The size of the cement pipe replaced on Central and Middlesex streets was twelve-inch, and on Broadway ten-inch. We had it all hauled to the yard. The ten-inch pipe we sold for seventy-five cents a length, and the twelve-inch pipe for all we sold we received one dollar each. The balance of it, which remains unsold, is now stored at the pipe yard and can be sold, as it makes good drain pipe, or it could be used for extending the overflow pipe at the Bodwell gate house down to the river, thereby saving the city from further claims for damages, as in the suit of Henry Emery decided last fall.

#### HYDRANTS.

Seven new hydrants have been set during the past year. The flush hydrant on Western avenue was taken out and a post hydrant set in its place. In taking up the cement pipe the old hydrants which were fed by four-inch pipes and had had but one two and one-half inch outlet, had to be taken out and replaced by five-inch hydrants of modern build, with larger outlets and improved valve and waste arrangement. Four of these hydrants were replaced on Broadway, three on Central street and one discontinued, and four on Middlesex street.

## LEAKS.

The greatest number of leaks this year were found in service pipes. Some of them were caused by back filling in sewers, and a few were found to have been eaten through where the ground was filled in by cinders and ashes. We had about fifteen leaks in service pipes altogether. We had two leaks in force main on Sixth street. Both of them occurred the same day, which is the case almost every year since the pipe was first laid. We also discovered about the first of May a leak in 24-inch main connection on Stackpole street, caused by the giving out of a lead joint. This same connection leaked last year, and is likely to give trouble again in the future unless the 24-inch main is extended and a new connection made.

## SERVICES.

The total number of feet of service pipe laid the past year shows an increase of 3,429 feet over the year 1886. Of the number of services 331 were new and 157 were changes, caused in most cases by the old iron service becoming filled with rust. There can be no doubt but that every three-fourths inch iron water pipe in the city will have to be changed, eventually, for lead or larger iron. During the year past, while we have allowed all applicants for service pipe to name the kind of pipe required, we have in no case laid less than one inch iron, and we have always recommended lead pipe. This we have done because lead pipe which has been taken up after being in the ground a number of years we found perfectly clean and containing no obstruction to the flow of water, whereas iron pipe under the same conditions was found to be so rusted as to reduce the capacity of the pipe over one-half, and in some cases completely stopping the flow of water through the pipe.



The amount of service pipe laid in 1887 is as follows:

$\frac{3}{4}$ inch wrought iron pipe.....	68 feet.
1 " " " .....	1,041 "
$1\frac{1}{2}$ " " " .....	209 "
2 " " " .....	406 "
$2\frac{1}{2}$ " " " .....	283 "
$\frac{3}{8}$ inch lead pipe.....	7,064 "
$\frac{3}{4}$ " " .....	1,500 "
1 " " .....	1,385 "

Total laid during 1887..... 11,956 "

Amount previously laid.....275,818 "

Total amount now laid.....287,774 "

Or 54 miles 2,654 feet.

Total number services put in.....7,780

Total cut off at main..... 362

Total reconnected..... 22

Total now in use.....7,440

59 services have been shut off for non-payment; 1 remitted, 50 paid, 8 remain unpaid.

Number and Kind of Services Changed During the Year Ending Dec. 31, 1887.

SIZE OF SERVICE CHANGED FOR.		$\frac{3}{4}$ inch lead.	$\frac{3}{4}$ inch lead.	1 inch lead.	1 inch iron.	$1\frac{1}{2}$ inch iron.	2 inch iron.	Number feet.
63	$\frac{3}{4}$ inch iron	2381						2381
57	$\frac{3}{4}$ inch iron		1903					1903
26	$\frac{3}{4}$ inch iron			989				989
2	1 inch iron			116				116
4	$\frac{3}{4}$ inch iron				93			93
4	$\frac{3}{4}$ inch iron					110		110
1	1 inch iron						58	58
157	Totals.....	2381	1903	1105	93	110	58	5650

## METERS.

There are now in use 1,530, an increase over last year of 69; new meters set during the year, 82, an increase of 22 over last year; meters taken out and others set in their places, 16; meters discontinued this year, 7; meters taken out for repairs, 214; meters destroyed by freezing, 2; tops bursted on crown meters by freezing, 4; Worthington meters cleaned and repaired, 43; Desper meters repaired at pumping station, 123. Total amount of money received for metered water, \$75,027.36.

## Meters Running January 1, 1888.

SIZE IN INCHES.	$\frac{1}{4}$ in.	$\frac{1}{2}$ in.	1 in.	1 $\frac{1}{2}$ in.	2 in.	3 in.	4 in.	Motor Register.	Total.
Desper.....	503	152	68	1					724
Worthington..	279	25	47	69	26	5	2		453
Crown.....	97	120	52	1	6		1		277
Ball & Fitts..	17	9	2	1					29
Duplex.....	12	14	10						36
Fitts Rotary..	6								6
Motor Registr.								5	5
Total.....	914	320	179	72	32	5	3	5	1530

## EXTENSION OF SMALL PIPE.

Small wrought iron main pipe to the extent of 2,543 feet has been laid during the year, the size of the pipe varying from one to two inches. This is 2,265 feet in excess of the amount laid in 1886. This pipe was laid in small courts where only a few houses would ever need water, or in streets where the grade or lines were liable



to change. In such cases small pipe was put in for temporary use.

Schedule of Small Pipe Laid.

STREETS.	1 inch.	1½ inch.	2 inch.	Tot. feet
Court off River.....	95			95
Court avenue, relaid.....			184	184
Court off New School.....			122	122
Common.....		123		123
Cheney avenue.....	48			48
Court off Lawrence.....		119		119
Dane avenue, relaid.....			239	239
Fruit.....			465	465
Hudson.....		120		120
Maguire court.....		159		159
Old Meadow road.....		395		395
Perry.....		135		135
Pollard avenue.....			134	134
Riverside avenue.....		58		58
Stanley avenue.....			122	122
Wilson.....	25			25
Total.....	168	1109	1266	2543

## MISCELLANEOUS.

In the month of September the banks of a sewer in process of construction on Crosby street fell in, breaking the main water pipe on the street and burying several lengths of it in the bottom of the sewer. It also necessitated the taking up of the line for a considerable distance, which was relaid after the sewer in that part of the

street was finished, together with seventy-eight feet of new pipe, which took the place of the pipe that was broken and lost in the sewer.

A thirty-inch pipe drinking fountain was set by the department at the junction of Bridge and Hampshire streets.

Three new four-inch fire services were laid during the year, two of them with four-inch hydrants connected for private use.

Previous to this year hauling the pipe from the cars to the yard, and from the yard to the streets where extensions were called for, was done by B. F. Brown, but owing to his refusal to do it at the same price this year and the inconvenience of delay in delivering the pipe when and where it was wanted, upon my suggestion another horse was purchased, also the truck used by Mr. Brown for that purpose. Since then the department has done all its own teaming of pipe, sand, paving, etc., saving thereby a considerably sum which was annually expended in this manner; also giving the department another horse, which was very much needed, as the three horses we had were overworked, due to the great increase in the territory supplied by the water works.

#### CONCLUSION.

I cannot close this report without speaking a good word for the employes of the department, both for those employed in the office and on the outdoor work. No man would want more faithful and intelligent work than they have performed the past year, and to them in a great degree is due the success which the department has attained.

I also cheerfully accord to the President and members of the Water Board my grateful thanks for their kindness and the confidence they placed in me during my official connection with the department this year.

Respectfully submitted.

ROBERT J. THOMAS,  
*Superintendent.*



## LOW SERVICE—WATER PIPES LAID IN 1887.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.					Total.
		4 in.	6 in.	8 in.	10 in.	12 in.	
Aiken Avenue, .	N'theast'ly from Cumberland Rd.		89				89
B, . . . .	Westerly toward Walker . . . .		37				37
Bachman, . .	Westerly from River . . . .		270				270
Bassett, . . .	Whipple and Hudson . . . .		305				305
*Broadway, . .	Fletcher and School . . . .				20	1410	1430
*Central, . . .	Union and Walnut . . . .					1415	1415
Clay, . . . .	Porter and Sherman . . . .		349				349
Clay, . . . .	Northerly from Porter . . . .		289				289
Cumberland Road	Northerly to Aiken Avenue . . . .		82				82
Exeter, . . . .	Northeasterly from River . . . .		429				429
Ford, . . . .	Extended northwesterly . . . .		48				48
Foster, . . . .	Southerly from Westford . . . .		239				239
Hancock Avenue,	Willie Avenue and Clark . . . .	188					188
Hovey, . . . .	River street easterly . . . .		345				345
Jenness, . . .	Extended westerly . . . .		96				96
Lawrence, . . .	Extended southerly to connect . .			348			348
Lilley Avenue, .	Extended westerly . . . .		155				155
Marlborough, .	Southerly from Westford . . . .		145				145
Mason, . . . .	Westerly from South Loring . . .		79				79
Mason, . . . .	Westerly from South Hastings . .		36				36
*Middlesex, . .	Garnet and Gorham . . . .					1255	1255
Oak Avenue, . .	Westford and Watson Avenue . .	183					183
O'Connell, . . .	Extended northerly . . . .	36					36
Otis, . . . .	Northerly and easterly . . . .		195				195
Parker, . . . .	Easterly from Stevens . . . .		850				850
Pawtucket, . . .	Westerly from Wilder . . . .			184			184
Pollard, . . . .	Linden and Chapel . . . .	132					132
Porter, . . . .	High and Clay . . . .		307				307
Royal, . . . .	Extended southerly . . . .		311				311
Sawtelle Place, .	Westerly from School . . . .		210				210
Sherman, . . . .	High and Clay . . . .		249				249
South Whipple, .	Northerly from Moore . . . .		152				152
Stanley, . . . .	Extended southerly . . . .		224				224
Stevens, . . . .	Southerly to Parker . . . .			402			402
Stevens, . . . .	Southerly from Parker . . . .			222			222

## LOW SERVICE—WATER PIPES LAID IN 1887—Concluded.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.					Total.
		4 in.	6 in.	8 in.	10 in.	12 in.	
St. Hyacinthe, .	Southerly from Tanner . . .		224				224
Wachusset, . .	Extended southerly . . . .		91				91
Ward, . . . .	Extended northwesterly . . .		211				211
Ware, . . . .	Extended southerly . . . .		138				138
Watson Avenue, .	Oak Avenue and Chelmsford, .	110	48				158
West Fourth, .	Extended northwesterly . . .		60				60
	Hydrants . . . . .		68				68
Laid in 1887 . . . . .		649	6435	1156	20	4080	12,340
*Less wrought iron cement lined taken out . . .							4,100
							8,240
Low service laid previous to 1887 . . . . .							414,064
Total low service to Jan. 1, 1888 . . . . .							422,304
Total high service to Jan. 1, 1888 . . . . .							16,047
Total high and low service to Jan. 1, 1888 . . .							438,351
Total in miles to Jan. 1, 1888 . . . . .							83.02

## HIGH SERVICE—WATER PIPES LAID IN 1887.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.	
		6 inch.	Total.
Christian . . . .	Tenth and Richards . . . . .	791	791
Richards . . . .	Christian street westerly . . . . .	85	85
	Totals . . . . .	876	876
	High service laid previous to 1887 . . .		15,171
	Total high service to Jan. 1, 1888 . . .		16,047

## LOW SERVICE—LIST OF HYDRANTS SET DURING THE YEAR 1887.

STREETS.	LOCATION.
†Bassett . . .	Northwesterly side, 2½ feet west of Hudson street.
*†Broadway . .	Northerly side, 258½ feet west of Mt. Vernon street.
*†Broadway . .	Northerly side, 322½ feet east of Mt. Vernon street.
*†Broadway . .	Northerly side, 4 feet west of Willie street.
*†Broadway . .	Northerly side, at line of Fletcher street.
*Central . . .	Westerly side, opposite Abbott street.
*Central . . .	Westerly side, 17 feet south of Elm street.
*Central . . .	Westerly side, opposite Cady street.
*†Middlesex . .	Southerly side, 94 feet west of Bowditch street.
*†Middlesex . .	Southerly side, near west line of Elliot street.
*Middlesex . .	Southerly side, near west line of South street.
*Middlesex . .	Southerly side, near east line of Pearl street.
Parker . . .	Northerly side, 6 feet east of Stevens street.
Parker . . .	Northerly side, about 71 feet east of Wilder street.
Pleasant . . .	Westerly side, 11 feet north of Rogers Farm line.
Tanner . . .	Southeasterly side, 217 feet northeasterly from St. Hyacinthe street.
Thorndike . .	Easterly side, 267 feet north of south line Highland street.
†Watson Avenue .	Northerly side, about 114 feet from Chelmsford street.

† Flush hydrants.

\* Old pattern taken out.

Taken out, hydrant on westerly side of Central street, near south line of Centre street.

Hydrant on Western avenue, opposite Elevator building, changed from flush to post hydrant.

# LOW SERVICE—LIST OF STOP GATES SET DURING THE YEAR 1887.

STREETS.	LOCATION.	4 in.	6 in.	8 in.	12 in.
Bachman . .	13.3 ft. northerly from southerly line Bachman, 1.5 ft. westerly from west line Hamblet.		1		
Bassett . .	18.8 ft. northwesterly from southeasterly line Bassett, 3 ft. northeasterly from northeasterly line Whipple.		1		
Broadway . .	16.3 ft. south of north line Broadway, 2 ft. east of east line School.				1
Exeter . .	23 ft. northwesterly from southeasterly line Exeter, 8.5 ft. northeasterly from northeasterly line Kiver.		1		
Foster . .	17.3 ft. westerly from easterly line Foster, 4.3 ft. southerly from southerly line Westford.		1		
Hovey . .	12 ft. northerly from southerly line Hovey, 1.6 ft. easterly from easterly line Kiver.		1		
Marlborough .	13.7 ft. westerly from easterly line Marlborough, 3.4 ft. southerly from southerly line Westford.		1		
*Mt. Vernon .	142 ft. north of north line Rock, 5.4 ft. west of east line Mt. Vernon.	1			
Oak Avenue .	5.5 ft. west of east line Oak Avenue, 7.4 ft. north of north line Westford.	1			
Parker . .	13.4 ft. southerly from northerly line Parker, 2 ft. westerly from easterly line Stevens.		1		
Porter . .	11 ft. south of north line Porter, 2 ft. east of east line High.		1		
Sherman . .	13 ft. south of north line Sherman, 3 ft. east of east line High.		1		
**Smith . .	1 ft. east of east line Smith, 135 ft. south of south line Snaw.	1			
South Whipple.	13.8 ft. easterly from westerly line South Whipple, 3.5 ft. northerly from northerly line Moore.		1		
Stevens . .	18.5 ft. easterly from westerly line Stevens, 18 ft. southerly from northerly line Parker.			1	
*†St. Hyacinthe	193 ft. southerly from southerly line Tanner, 10 ft. east of Runels mill.	1			
HIGH SERVICE.					
Christian . .	3 ft. south of south line Tenth, 10.4 ft. east of west line Christian.		1		

\* Otis Allen & Sons' fire service.

\*\* Shaw Stocking Company's fire service.

\*† George Runels's fire service.



## Property at Pipe Yard January 1, 1888.

## SCHEDULE OF MAIN PIPE AND SPECIAL CASTINGS.

DIAMETER IN INCHES.	4	6	8	10	12	16	20	24	30
Lengths .....	65	8	6	24	50	5	17	8	4
Sleeves .....	7	4	6	5	2	10	5	9	7
Caps .....		14	23	8	16	3	1	1	
Curves .....	6	4	12	2	8	4	10	8	
Plugs .....	2	7							

DIAMETER IN INCHES.	4x4	6x4	8x6	10x6	10x8	12x6	12x8	12x10	12x12	14x8	16x8	16x12	16x16	18x6	18x8
3-Way .....				2			5			2	1				
4-Way .....	1		2		1	5	1		1	1				5	5
Reducers .....		7	3		2	4	3	1				1			

Stop gates, 1 4-inch, 2 6-inch; wrought iron pipe, 12 feet 1½-inch, 24 feet 2-inch; 1 reel ¾-inch lead pipe, 1 reel ¾-inch lead pipe, 40 feet 1-inch; 7 ¾-inch tees; 10 1½-inch crosses, 12 1x¾-inch, 12 ¾-inch elbows, 8 1x¾-inch, 16 2-inch unions; 6 2x1½-inch bushings; 15 1-inch plugs; 20 reducing couplings; 39 ¾-inch solder nipples; 10 1-inch sidewalk cocks; 11 unions; corporation cocks, 6 ¾-inch; 2 1-inch cellar cocks; 4 1-inch iron sidewalk cocks, 30 ¾-inch; 18 1-inch lead unions, 18 ¾-inch; 1 1-inch bushing, brass; 7 brass plugs, 15 ¾-inch; 2 iron hydrant boxes, 1 stop gate box, 6 iron sidewalk boxes, 7 joints earthen pipe for sidewalk boxes, 2 buck saws, 2 saw horses, 1 machine for testing main pipe, 2 pipe benches, 2 tool boxes, 3 derricks, 2 fall ropes, 2 set blocks, 6 draught chains, 10 wheelbarrows, 2 tongs for cleaning sidewalk boxes, 4 hydrant frames, 10 hydrant covers, 2 gate box frames, 2 gate box covers, 2 drinking fountains, 24 picks, 18 pick handles, 7 square point shovels, 20 round point shovels, 10 scrub brooms, 4 hand brushes, 11 pair rubber boots, 15 lanterns, 30 feet rubber hose, 1 hose reel, 2 brass goose necks, 6 calking sets, 3 nail hammers, 100 sidewalk box caps, 200 feet canvas hose, 300 feet 2½-inch rubber hose, 30 iron lug straps, 250 pounds assorted bolts, 12 assorted files, 12 assorted gravel screens, 20 pounds cotton waste, 2 trowels, 10 pounds iron washer, 30 pounds assorted nuts, 3 hand hatchets, 1 ax, 5 sling ropes, 1 dualin pot, 9 striking hammers, 4 hand hammers, 2 paving hammers, 200 pounds pig lead, sets old blocks, 2 lead pots, furnace for melting lead, 1 zinc pump, 2 copper force pumps, ½ keg 30d nails, 40 assorted wrenches, 14 rammers, 3 paving mauls, 1 barrel cement, ¼ barrel white clay, 1 snow shovel, 1 blacksmith shop, 1 work shop, 1 carriage house, 1 stable, 1 store shed, 2 spirit levels, 3,000 feet lumber,



2 patterns for making gate and hydrant boxes, 1 set blacksmith tools, 400 pounds steel in drills, 4 scrapers for blasting purposes, 4 pounds pipe wedges, 3 yarning irons, 1 lead ladle, 10 crow bars, 4 horses, 3 express wagons, 2 light wagons, 2 trucks for handling pipe, 4 horse blankets, 2 pungs, 1 sleigh, 2 horse brushes, 4 single harnesses, 1 double harness, 2 1-inch lead connections, 3 street horse blankets, 4 halters, 2 hay forks, 2 manure forks, 1 wagon jack, 2 wagon wrenches, 2 canvas covers for horses, 5 tons hay, 1 post hydrant, 15 old style second-hand hydrants, 12 pipe tongs, 2 Stilson wrenches, 4 monkey wrenches, 3 tapping machines, 20 dippers for drinking fountains, 125 feet block tin tubing, 1 30-foot extension ladder, 2 24-foot ladders, 2 ratchett cutters, 3 pipe cutters, 20 dies, 2 ratchett die plates, 1  $\frac{3}{4}$ -inch tap, 1 1-inch tap, 1  $1\frac{1}{2}$ -inch tap, 100 feet block tin wire, 1 solder pot, 2 solder moulds, 1 charcoal furnace, 1 naphtha furnace, 5 soldering irons, 15 gate spindles, 2 disks, 11 hydrant spindles, 8 hydrant valves, 12 hoes, 30 hydrant packings for top, 34 for bottom, 68 5-inch assorted hydrant packings, 10 packings for 4-inch gates, 1 map distributing main pipe, 1 map showing stop gates, 1 map of Lowell, 1 10-gallon can, 1 Edison patent pump, 9 feet 4-inch rubber hose,  $\frac{1}{2}$  ton stove coal, 2 portable closets,  $\frac{1}{2}$  gross lamp wicks, 1 blasting battery, 1 desk, 8 pounds dualin, 4 S curves, 1 pattern for S curves, 250 lengths second-hand cement-lined pipe, 2 stone hammers,  $\frac{1}{4}$  ton blacksmith coal, 36 pounds plumbers' solder, 3 paint brushes, 3 paint pots, 1 marlin spike, 2 dozen lights window glass, 10 pounds calking yarn, 6 logs for blasting purposes, 1 Worthington  $\frac{3}{4}$ -inch meter, Desper 2  $\frac{3}{4}$ -inch, 1 1-inch, Crown 2  $\frac{3}{4}$ -inch, 8 tops for Worthington meter, 30 covers, 15 valves and 10 valve seats, 30 spindles for Worthington meter, 30 out and inlet connection for Desper meter, 6 lead connections for Worthington meter, 3 set packing patterns, 1 roll packing paper, 4 pounds sealing wax,  $\frac{1}{2}$  box crayons, 25 pounds leather, 1 pair cut nippers, 1 brass lamp, 1 leather tool bag, 1 pair pliers, 200 brass unions for  $\frac{3}{4}$ -inch meters, 20 brass nipples and unions, 12 brass unions for  $1\frac{1}{2}$ -inch meters, 4 brass unions for 2-inch meters, 1 5-gallon can, 2  $\frac{1}{2}$  gallon, 1  $\frac{1}{4}$  can, 1 sieve and cover, 1 coal stove, 1 coal hod, 2 brooms, 1 pail and tank for testing meter, 1 platform scale, 1 counter scale, 1 clock, 6 pairs pipe tongs, 1 flush hydrant, 2 pipe vises, 5 screw drivers, mallet, 1 claw hammer, 1 hatchet, 1 foot lathe, 1 lathe dog, 2 bit stocks, 2 bits, 1 hand saw, 1 washer cutter, 2 soldering irons, 1 2-inch augur, 1 bench block, 1 fore plane, 1 set numbers, 6 tops for  $\frac{3}{4}$ -inch Crown meter, 5 tops for  $\frac{3}{4}$ -inch, 8 pistons for  $\frac{3}{4}$ -inch Worthington meters.

#### Property in Water Board and Superintendent's Office.

17 chairs, 4 high stools, 1 letter press, 7 desks with drawers, 3 standing desks, 3 office tables, 2 book cases, 1 bill cabinet, 20 ink-stands, 1 clock, 1 glass mug, 3 waste baskets, 8 spittoons, 4 wrenches, 1 pick, 1 map of distributing main pipes, 1 large rubber mat, 3 grass mats, 1 water gauge, 1 screw driver, 1 safe, 1 key rack, 1 atlas of

Lowell, 1 instrument for testing capacity of engines, 1 apparatus for making gate boxes, 1 hat rack, 1 umbrella rack, 1 water cooler.

#### Property and Tools at Pumping Station.

1 pipe vise, 1 work bench, 1 portable forge, 8 sets of braces for engines, 2 sets differential blocks, 100 feet 2 inch rope, 1 set fire irons, 1 brass hydrant, 1 axe, 11 finished wrenches, 3 hand saws, 2 jack screws, 1 cold chisel, 2 ratchet drills, 1 socket drill, 4 calking chisels, 1 barometer, 2 thermometers, 1 office desk, 1 indicator, 1 oil cupboard, 2 oil dishes, 1 platform scale, 4 crow bars, 64 feet  $\frac{3}{4}$ -inch iron chain, 16 eye bolts, 1 truck, 1 key wrench for air pump, 1 iron wheelbarrow, 1 buck saw, 2 gas lamps, 1 high grade thermometer, 4 brass bolts, 4 spare valves for Morris engine, 5 sets spare wrenches for valves, 11 wrenches for Morris engine, 11 wrenches for Worthington, 3 sledge hammers, 10 drills, assorted sizes, 5 bits, 2 bit stocks, 1 25-foot ladder, 1 20-foot and 1 18-foot, 1 pair steps, 1 hoe, 2 rakes, 1 small die plate, 1 fore plane, 6 monkey wrenches, 1 piece 2-inch rope, 3 chisel bars, 2 small taps, 4 socket wrenches, 2 14-quart iron pails, 4 hand hammers, 2 grind stones, 1 anvil, 7 gas tongs, 1 hydrant wrench, 2 clocks, 1 full set of dies, from  $\frac{1}{4}$ -inch to 2-inch ratchett, right and left, with 2 die plates, 1 die stock and bushings, 2 sets blocks, 3  $\frac{1}{4}$ -inch chains, 1 24-inch elbow, 1 ratchett wrench for 30-inch gate, 1 scythe, 1 snath, 7 chairs, 1 office table, 2 engine lathes, 1 speed lathe, 1 upright drill, 31 turning tools, 1 12-inch chuck, 1 6-inch chuck, 1 number 3 drill chuck, 1 number 2 drill chuck, 3 reamers for Desper meters, 4 small reamers, 16 twist drills, 3 lanterns. Extras—2 bench vises, 4 assorted steel wrenches, 1 meter chuck, 1 black walnut book case, 1 black walnut cabinet, 1 small slide valve engine, 3 extra twist drills, 12 lathe dogs, 3 hack saws, 1 blow pipe, 1 hay scales, 2 small jack screws, 1 small Scotch drill, 1 furnace pot, 2 trowels, 1 tar kettle, 450 feet sheathing, 3 wheelbarrows, 2 pipe cutters.

#### Property at Reservoir.

1 iron tooth rake, 1 hay fork, 3 shovels, 1 ax, 1 piece 1-inch rope, 1 scythe and snath, 1 grass hook, 3 thermometers, 1 stop gate wrench, 1 sidewalk wrench, 1 coal stove, 2 lanterns, 1 ice chisel, 1 nail hammer, 1 saw, 1 carpenter's square, 2 hoes, 1 piece rubber hose, 2 chairs, 1 sectional ladder, 1 dwelling house, 1 stable, 1 wheelbarrow.

#### Tools and Property at Filter Inlet.

2 iron tooth rakes, 11 shovels, 1 rammer, 1 ax, 2 ice chisels, 1 stop gate wrench, 1 nail hammer, 1 pick, 2 brooms, 1 wheelbarrow, 1 boat, 1 set of oars.



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CITY ENGINEER

SIXTEENTH

ANNUAL REPORT

★ OF THE

LOWELL WATER BOARD

AND REPORTS OF

SUPERINTENDENT OF WATER WORKS  
AND CITY ENGINEER

1888



SIXTEENTH  
ANNUAL REPORT  
OF THE  
LOWELL WATER BOARD,  
TO THE  
CITY COUNCIL OF THE CITY OF LOWELL, MASS.,  
AND THE  
REPORTS OF THE SUPERINTENDENT OF WATER WORKS AND  
OF THE CITY ENGINEER TO THE WATER  
BOARD, FOR 1888.



LOWELL, MASS.  
VOX POPULI PRESS, 130 CENTRAL STREET.  
1889.

42848

909

## CITY OF LOWELL.

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IN BOARD OF ALDERMEN, Jan. 22, 1889.

Received and ordered on file without reading.

Sent down for concurrence.

GIRARD P. DADMAN, *City Clerk.*

IN COMMON COUNCIL, Jan. 22, 1889.

Received and ordered on file, in concurrence.

DAVID CHASE, *Clerk.*

# WATER DEPARTMENT, 1888.

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## WATER BOARD.

MILES F. BRENNAN, *President.*

EDWARD D. HOLDEN.

HARRY E. SHAW.

EDMUND B. CONANT.

ARNOLD S. WELCH.

CHAS. L. KNAPP, *Secretary and Clerk.*

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ROBERT J. THOMAS, *Superintendent.*

THOMAS F. DOYLE, *Foreman.*

ROBERT GARDNER, *Meter Inspector.*

WILLIAM JOYCE, *Assistant Foreman.* ANTHONY F. COGER, *Services.*

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LEONARD T. FARRIS, *Service Clerk.*

GEORGE W. WORTHEN, *Meter Clerk.*

MARY G. SAWYER, *Assistant Clerk.*

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JAMES P. ROBERTS, *Engineer.*

THOMAS McLAUGHLIN, *Asst. Engineer.*

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## *Inspectors.*

JOHN J. BANCROFT.

JULIAN L. WHITESIDE.

THOMAS LENNON.

WILLARD S. KNOWLTON.

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FRANK LAPOINT, *Reservoir.*





# REPORT OF THE WATER BOARD.

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OFFICE LOWELL WATER BOARD,  
LOWELL, Jan. 14, 1889.

*To the Honorable the City Council of the City of  
Lowell:*

In compliance with the requirements of Chapter 39 of the Ordinances, the Lowell Water Board respectfully presents its sixteenth annual report of the receipts and expenditures of the department under its control for the year 1888, together with information and suggestions deemed of importance. We also transmit at this time the annual reports of the Superintendent of the Water Works and of the City Engineer. Appended is a special report of the Water Board upon the subject of mechanical filtration, showing result of investigations pursued during the year in the effort of solving the problem of how to improve the quality of the Merrimack River water as supplied inhabitants of Lowell by the Lowell Water Works.

## ORGANIZATION.

The members of the Lowell Water Board, as elected to serve during the year 1888, consisting of Miles F. Brennan and Arnold S. Welch, from the citizens, Alderman Edward D. Holden and Councilmen Edmund B. Conant and Harry E. Shaw, met for the purpose of organization, in accordance with the ordinance, May 7, 1888. Miles F. Brennan was elected President, and at a subsequent meeting Charles L. Knapp was elected Clerk of the Board.

## THE YEAR'S WORK.

The portions of the year's work coming under the direct supervision of the Superintendent will be found described in detail, in that official's report, while all matters of record relative to work performed at the pumping-station, as in previous reports, is to be found in the Civil Engineer's Report, both of which accompany our report.

## SUMMARY.

Items of leading interest are here noted:

Total length water mains laid, season of 1888...	14,099	
Total length water mains re-laid, season of 1888,	3,385	
		17,484 ft.
Total length water mains laid, season of 1887...	9,116	
Total length water mains re-laid, season of 1887,	4,100	
		13,216 ft.
Total length of mains to date..452,450 ft., or 85.69 miles.		
New water service connections in 1888.....	336	(11,305 ft.)
New water service connections in 1887.....	331	(11,956 ft.)
Total number and length of services to date, 8,115	(299,079 ft. =	
56 miles 3,399 ft.)		

Number of services disused (disconnected from main).....	21
Number of services in use at present.....	7,755
Number of water meters set in 1888.....	100
Number of water meters set in 1887.....	83
Total number of meters to date.....	1,630
Total number of water takers to date.....	15,500
Estimated population supplied.....	70,000
Number of services shut off for non-payment, 1888,	126
Number of services shut off and since let on and paid,	95
Number of services shut off by error.....	3
Number of services now shut off for non-payment,	28
Number of hydrants set in 1888.....	24
Total number of hydrants in city to date.....	823
Salaries and pay-roll, 1888.....	\$ 32,124 25
Salaries and pay-roll, 1887.....	29,801 81
Total charges, all sources, 1888.....	185,012 92
Total charges, all sources, 1887.....	184,395 24
Total charges of 1888 (not including the months of October, November, and December), <i>i. e.</i> , first nine months of year.....	165,968 23
Uncollected charges for same period as above, not including shut-off list for non-payment.....	342 32
Charges previous to Jan. 1, 1888, remaining unset- tled, not including shut-off list.....	284 42
Bonded indebtedness (net) of city on account of the Water Works, Dec. 31, 1888.....	1,191,160 17
Total receipts, all sources, 1888 (including 1887 bal- ance, \$5,384.59).....	188,523 96
Total expenditures, including interest account.....	183,279 73
Balance carried to 1889 account.....	*\$5,244 23

\* In making comparisons with figures of previous years it should be borne in mind that at the commencement of 1888 the price charged the city of Lowell for fire hydrants was reduced from an annual charge of \$20 per hydrant to \$12,—a net loss of \$6,084 in available resources in 1888. It will be readily seen that with this, and upon the same footing as in 1887, the balance or amount of receipts over expenditures would be more than \$11,000.

Total receipts, all sources, 1887 (including 1886 balance, \$4,056.38) .....	182,334 64
Total expenditures, including interest account.....	176,950 05
Balance carried to 1888 account.....	\$5,384 59
Total expenditures on Water Works to Jan. 1, 1889,	\$4,453,583 47
Total receipts from Water Works to Jan. 1, 1889..	2,070,187 01
Net cost of Water Works to Jan. 1, 1889.....	\$2,383,396 46
Total interest paid during 1888.....	108,045 00
Total interest paid during 1887.....	109,665 00
Total amount of water pumped (U. S. gallons), 1888,	1,822,042,490
Total amount of water pumped (U. S. gallons), 1887,	1,578,992,610
Daily average pumped (U. S. gallons), 1888.....	4,978,258
Daily average pumped (U. S. gallons), 1887.....	4,326,007
Total consumption of coal, 1888 .....	1800 <sup>77.9</sup> / <sub>2000</sub> tons.
Total consumption of coal, 1887 .....	1467 <sup>48.0</sup> / <sub>2000</sub> tons.
Total consumption of coal, 1886 .....	1392 <sup>16.6</sup> / <sub>2000</sub> tons.
Cost pumping 1,000,000 gallons, Morris engine, 1888.....	\$6 47
Cost pumping 1,000,000 gallons, Morris engine, 1887.....	6 65
Cost pumping 1,000,000 gallons, Morris engine, 1886.....	6 52
Cost pumping 1,000,000 gallons, Worthington engine, 1888..	7 86
Cost pumping 1,000,000 gallons, Worthington engine, 1887..	7 89
Cost pumping 1,000,000 gallons, Worthington engine, 1886..	7 53
Average price of coal, Morris engine:	
	1888, \$4.47; 1887, \$4.31; 1886, \$3.92.
Average price of coal, Worthington engine:	
	1888, \$4.42; 1887, \$4.29; 1886, \$3.87.

## QUALITY OF THE WATER.

During the season of 1888, the condition of water supplied the inhabitants of Lowell has been excellent. This is a statement of fact based upon the results of expert examinations made at regular intervals during the year. The result of our own investigations will be found as part of our special

report upon mechanical filtration. The water of this year has been far superior in quality for domestic uses to water furnished for several years. The condition of the river, following an almost unprecedented year's rain-fall, is largely the cause of this most desirable condition of the river water, although the renewed use of the filter basin as an aid in supplying the filter gallery through the summer months, at least, contributed material aid. It is, however, well for your honorable body to understand that the purification of Merrimack River water will never be accomplished by means of natural filtration through the river banks, or by means of artificial beds. Such a system on a very much enlarged scale from the present plant above Pawtucket Falls, and necessarily at a very large additional cost to the city, would undoubtedly supply Lowell with pure water during periods of the year. But it would be worthless during a greater portion of the remainder of the year. That is, when the river is at its maximum state of pureness, you would have the means of making the water purer before it entered the city mains; but when at its maximum foulness, and when filtration is actually necessary, the natural system would be a total failure, and would continue so to be as long as Merrimack River water freezes and the annoying silt exists in its waters. This knowledge has been dearly paid for. Believing this, the Water Board of 1888 turned its attention to mechanical filtration. It is not that



there is any cause for alarm; upon that point the public mind may be at ease.\* Any intelligent person, if he cares to investigate, can satisfy himself from his own observation. It is easy for him to understand fully the signification of a chemical analysis of water, if he will. And if he will do this, the mischief caused by the most reprehensible action of ambitious venders of a great variety of "spring" waters would be lessened materially.

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\* The following note is supplied by J. Arthur Gage, A. M., M. D., with special reference to the significance of analysis of Merrimack River water:

The albuminoid ammonia, the free ammonia, and the nitrates, represent in the order given the forms in which vegetable and animal matters appear in water. Since the Merrimack has peculiarly pure sources, and is mostly free from vegetable contamination, they stand here as a measure of the sewage poured into the river. A swift river, running over rapids, has the power to eliminate a certain amount of poisonous substances, and up to 1873 the Merrimack did this: the albuminoid ammonia was then 0.006 parts in 100,000, about the same as Winnipisseogee; since then it has increased to 0.020 parts, and there has been a corresponding increase of the free ammonia and nitrates. This is not so high as many other water supplies in Massachusetts, and is chiefly significant in that it shows increase of sewage.

The color and turbidity indicate the presence of mineral as well as other impurities, and are increased after heavy rains. Roughly, the darker the color, the more impurities present.

The solids include the vegetable and animal matter ("lost on ignition") and the mineral salts ("fixed"). The "fixed" solids are, as a rule, harmless, unless they include chemical poisons, as arsenic, lead, or copper, and are increased when the water becomes turbid. The solids ("lost on ignition") correspond with the ammonias, and represent the organic poisons that are to be avoided. The percentage of these solids in Merrimack water is not excessive, as compared with other waters, but is on the increase.

Chlorine is an important element in water analysis, and does not

## CONSUMPTION AND WASTE OF WATER.

We ask your careful and earnest consideration to what, in our minds, is the most important question that is dealt with in this report, viz.: How shall the present enormous waste of water drawn from our reservoirs be checked? We ask that you consider carefully: First, our present capacity for

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disappear on filtration. It is a constituent of common salt, and occurs in waters that run over salt beds, those that are very near the sea-coast, or those that contain or have contained sewage. The Merrimack runs over a bed of granite and gravel, and is, at its sources, remote from the sea; consequently, chlorine here represents sewage. If the chlorine and free ammonia are high in amount, sewage is usually present, and the albuminoid ammonia will be found also high. If the ammonias are high, with but little chlorine, vegetable matter is then the cause of contamination.

Chemists agree that a water supply should not habitually contain more than 0.008 parts free ammonia, 0.015 albuminoid ammonia, and 1.0 or 2.0 of chlorine, to 100,000 parts water. The river at Lowell has a small amount of free ammonia and chlorine, but a slight excess of albuminoid ammonia. I should consider 1.0 or 2.0 parts of chlorine as indicating a dangerous amount of contamination for Merrimack River water, particularly if there was a simultaneous increase of ammonias.

In conclusion, the water at Lowell is still within the limits of safety; but from what is known of its sources of pollution, and the gradual TENDENCY TO INCREASE in all the deleterious elements shown by chemical analysis, it is gradually approaching a point where it can not be used with that degree of safety that is desirable to exist. In the light of our present knowledge, therefore, any efforts to remove the growing impurities from our drinking water are highly commendable.

There is at the present time, among experts, an aversion to recommend the use of water, into which sewage has been poured, for domestic purposes, though the chemical tests do not show a large amount of ammonia and chlorine; and it is hoped that biological tests may throw light on this subject.

LOWELL, Dec. 17, 1888.



pumping; second, the consumption of water during the heated term of summer and the coldest days of winter. It is not enough to say our own is but the experience of other cities. True this is, as we are prepared to show by the following figures recently obtained:

New England Cities.	Popula- tion.	Gallons, Consumption Daily.	Daily Per Capita.	No. Meters.	Services.
Lowell .....	75,000	4,978,250	66.5	1,630	8,115
Manchester .....	41,000	2,000,000	50	800	3,300
Salem .....	28,200	2,100,000	73	135	8,400
Lawrence .....	40,000	2,520,000	68½	918	10,684
Lynn .....	49,500	2,379,000	48.1	271	7,800
New Bedford.....	37,500	3,280,000	88	105	5,495
Portland, et al....	50,000	6,000,000	120	235	6,700
Providence .....	123,000	5,375,500	43	7,936	13,564
Springfield .....	40,000	4,000,000	100	500	4,819
Newton.....	22,000	710,000	32.3	2,500	3,950
Hartford.....	45,000	5,000,000	110	302	10,759*
Worcester.....	82,000	4,007,000	55	7,354	8,704
Fall River.....	64,000	1,590,960	24.86	2,941	4,250
Boston .....	395,000	37,481,100	76.7	3,534	53,400
Cambridge .....	70,000	4,137,947	59.11	221	16,044

\* Families.

Newton, as will be seen by the foregoing table, consumes per capita 32.3 gallons daily. Their manner of assessment of water rates formerly was the

same as practised in Lowell. By a new ordinance a radical change was made. By its provisions all service pipes supplying other fixtures than ordinary faucets for domestic use must be metered. The meters are furnished, set, maintained, and to be renewed by the department, the water-takers paying an annual rental for their use, and being at no other expense in connection therewith except to protect them against frost or repair all frost damage. This change necessitated the purchase of a large number of meters, and the city purchased one thousand Crowns, the same as used in Lowell. When the following authoritative figures are studied, it will be realized, by the experience of Newton at least, what can be saved by compulsory use of meters.

J. T. Fanning, C. E., in his work on "Water Supply for Cities," gives as the requirements of American cities, as follows:

"For ordinary domestic use, not including hose use, twenty gallons per capita per day.

"For private stables, including carriage-washing, when reckoned on the basis of inhabitants, three gallons per capita per day.

"For commercial and manufacturing purposes, five to fifteen gallons per capita per day.

"For fountains (drinking and ornamental), three to ten gallons per capita per day.

"For fire purposes, one to ten gallons per capita per day.

"For private hose, sprinkling streets and yards, ten gallons per capita per day during the four dryest months of the year.

"Waste, to prevent freezing of water in service pipes and house fixtures in Northern cities, ten gallons per capita per day during the three coldest months of the year.

"Waste, by leakage of fixtures and pipes, and use for flushing purposes, from five gallons per capita per day, upwards."

The same authority estimates the average daily consumption, basing his calculations entirely upon population :

Places of 10,000 population,	35	to	45	gallons per capita.
" " 20,000	"	40	"	50 " " "
" " 30,000	"	45	"	65 " " "
" " 50,000	"	55	"	75 " " "
" " 75,000 and upwards,	60	"	100	" " "

In calling attention to the foregoing New England cities, we realize the varying surrounding conditions, but familiarity with the cities cited will provide all necessary explanations or qualifications.

Possibly these cities have a greater surplus of pumping capacity than we. Whether such is the case or not, does not alter the fact that there does exist an alarming waste of water, permitted by a condition of things entirely at variance with methods pursued by business men, in ordinary business affairs. To illustrate, we will take the record of the year 1887: The total amount of water pumped was 1,578,992,610 gallons, or 210,532,348 cubic feet. This amount of water at 15 cents per hundred cubic feet amounts to \$315,798.52. The actual amount charged for water during the above year, was \$177,425.51, or a loss of \$138,373.01. You will bear in mind that, marked as are these figures, the actual discrepancy is even greater; for, of the 15,000 water-takers of city water in 1887, only 1,530 were on meter rates, and, in theory, at least, a meter is used to save money for the consumer. We have,

during the year, devoted much thought to the important matter, and have caused to be made a number of tests, to ascertain, if possible, what was a fair basis to build upon for actual consumption per capita. In a tenement block, with seventy occupants, the plumbing first-class in every detail, having a total of 45 taps, including 20 water-closets, the average daily run as read upon the meters, two being used, one to serve as a check upon the other, was 102.5 cubic feet per diem, or 10 U. S. gallons per capita. This, it may be said, is an extreme case. So it is. The families are intelligent, well-meaning people; leakages are common, but are repaired at once; the meter records are looked at twice a week by the one in charge of the property. Near each tap and in every water-closet is this notice:

This water is metered,—that is, paid for by the gallon. Use all the water needed, BUT DO NOT WASTE. Please report to owner if water does not shut off tight after using.

The experiments made with the above property were by one of our officials. It simply shows what care will do. Consider for a moment, that by the City Engineer's records, the average daily consumption of water in 1887 was 4,319,164 gallons, or 63 gallons to each consumer; and that in the winter

of 1888, days and nights occurred when the consumption was greater than 9,000,000 of gallons. The reasoning mind will admit that on the 1887 daily average of 4,326,007 there was a tremendous waste; but what shall he say, confronted by a daily consumption of 9,000,000 gallons? True, this draught was but temporary, lasting as long as did the extreme cold weather; but while it did last, your pumping appliances, powerful as they are, were taxed to their utmost. The mere thought of an accident to either of the engines at such a time is sufficient to unnerve the strongest. While this 9,000,000 gallons of water was running,—at least 7,000,000 to waste,—what was your protection against fire? The pressure in the mains must have been, in many portions of the city, actually too light to furnish water for fighting fire.

It is criminal negligence to permit the existence of such a condition of affairs; but will your honorable body point to us the remedy? It might be presumed that, with a serious conflagration under way, with failure of water supply, heroic measures would be resorted to, and certain sections of the city be cut off from water supply without notice. Such an event would be the last resort; but if it should occur, it would undoubtedly be attended by serious and costly damage in such sections of the city as were cut out. In making these statements, we do not wish to pose as alarmists; but this evil of running water to waste has become so great as

to justify extreme measures. There is not the slightest doubt that hundreds of house connections are allowed to run both night and day, as the consumption during the night is almost equal to the amount used during the day, during cold periods. This can only be attributed to wanton carelessness or gross ignorance. A plumber, amenable to no law, runs his pipes as he sees fit, without regard to exposure; work is performed in the cheapest possible manner, and as a result, the owner of a building thinks himself justified in running water to prevent freeze-ups; the consequence being, the city suffers the penalty, paying dearly for its neglect in failing to assume some authority in the direction and supervision of plumbers' work. There are plumbers whose inclination is to do proper work; but competition with others, who are entirely irresponsible, renders a property-holder's chance for honest work not what it should be, nor what it would be, if proper laws were enacted in the interest and for the protection of the property-holder.

Before leaving this subject of waste water, we desire to speak of an evil, the results of which we foresee as one of the disastrous certainties of the present winter. The Board of Health, with commendable zeal, have, during the summer, made war upon that relic of the century past—the privy vault. In many cases, the structures condemned were in back yards or contained in flimsily-constructed out-houses. The property-owner, conforming to the rule



and order of the Board of Health, replaced the privy vault by water-closets. These, in numerous cases, are practically out-of-doors and wholly exposed to winter. What will follow? One of three things must occur: the water shut off and the water-closet disused, a freeze-up, causing ruin to the plumbing and consequent disuse, or a permitted, continuous run of water night and day. We say we foresee the result of this evil. A large, extra draught of water is certain,—this at the expense of the city,—that these exposed water-closet privileges may be maintained. The wisdom of continuing the policy of permitting water-closets to be thus located in these exposed places, is a matter for your honorable body to seriously consider. As a business proposition, the idea of pumping water for a continuous flowage through these or any other water-closets is, it seems to us, preposterous. We estimate that one of these water-closets will run in twenty-four hours from 1,500 to 2,600 cubic feet, according to size of pipe. This amounts in money, at metered rates, to from \$2.25 to \$3.90. A water-closet, at schedule rates, allowing use by eight persons, pays the city \$4.00; twelve persons, \$6.00 annually. Is there any business in the world that can long sustain itself, allowing such practices?

Some years since it was the custom of the Water Department to employ an inspector, whose special duty it was to search for leaks. As for results following this work, it is the testimony of those in

the employ of the department at the time mentioned, the good derived was of doubtful quantity. It seems to this Board, however, that the lack of good results was due more to failure of application of penalties provided by the Ordinances, rather than from any lack in the working of the system. It is our experience that leaks are continually being found upon premises where meters are used,—that is, on property where the waste of water is guarded by the owner for his own interest.\* On the other hand, where property uses water under annual-rate charges, and where the amount of water used is of no monetary concern to owner, leaks are not frequently called to notice of Water Department by the owner. Having, as we do, ten rate services where we have one metered service, the fact is at least significant, and warrants suspicions of existing waste.

The situation, then, is just this: when water is metered, the department furnishes inspectors, whose special duty is to see that every thing is tight and in proper order; where property is upon rates, there is practically no oversight. This department has had no access to very many pieces of property for years. We believe that it would be to the advantage of the city were a leak inspector added to the present force, his duty being to inspect every piece of piping and fixtures in the city periodically. For such service we should recommend some individual who has had experience in the Water Department. There is no question that such an inspector, doing



his duty, could and would save the city of Lowell a large amount of waste, provided that when leaks were reported, and the owner notified of such fact, in case the proper repairs were not speedily made, the penalty be applied as provided by the Ordinances. This would be the course of any business man. Why should we hesitate in the matter of the application of business methods in the handling of the city's interest?

In Boston a certain number of the inspectors of waste are detailed to investigate wastes and enforce the application of remedies. The Boston Water Board Report for 1886 says: "The larger part of leaks and wastes, found by house-to-house inspection, result from defective or worn-out fixtures. But where, during 1883, the returns indicated defects in twenty per cent. of the fixtures examined, there now appears at each recurring visit to be not more than five per cent. These minor cases of waste will inevitably be developed by every periodical inspection. Fixtures will wear out or get out of order, owners will delay repairs, and small wastes will occur, which, in the aggregate, reach a considerable amount." This matter of waste certainly deserves the earliest attention of the Lowell Water Board of 1889. In connection with, and as a continuation of, this subject we will speak of

#### METERS.

What is said upon this subject must be prefaced by a word concerning the present rates as charged

to water consumers. Presuming they are familiar to you, we will state that in our opinion a careful revision would result in a far more equitable system of charges. We believe the prescribed "minimum" charge of \$12 for metered water totally unjust. Its reduction or abolishment would undoubtedly lead to a wider use of meters. Why should you, as a meter owner, pay \$12 annually for less than that money's measure of water, while your neighbor, paying annual rates, can, and in many cases does, actually use, for less charges, two or three times the amount of water you are permitted? The theory has been that the introduction of meters tended to materially lessen the income of the water department. But, if under a system of rate charges, it becomes necessary to pump two, three, and even four millions of gallons for every one million actually used and paid for, the fallacy of the theory becomes apparent. This prepares us to say that there is a course to pursue, as an act of retrenchment, economy, and self-preservation. It is this: Place a meter on every service in Lowell, or if it were practicable, on every tap used in the city, excepting only the ordinary domestic uses which come under the \$6 family rate charge. Such a course would necessitate the city's purchase of a large number of meters, which could be rented at an annual fee as is practised in other cities. It would necessitate an increased force of meter inspectors both for repairs and reading. It would save an enormous quantity of waste. In fact, the problem

resolves itself to this: Would the saving in cost of pumping equal the increase of running expenses of office work? In the opinion of this Board there is not a doubt that it would. All doubt as to the sufficient capacity of our street mains would be then removed.

Economy in the use of water does not necessarily imply niggardliness. There are innumerable examples from our own as well as from the experiences of other cities, to show conclusively what can be accomplished in the saving of water by the compulsory use of meters, simply as a detector of leaks that would otherwise escape discovery. One case will illustrate. At Grand Rapids, Mich., the compulsory meter system was adopted after a trial of the annual-rate system. A meter was set on a service supplying a business block of three stores, with boarding-house above. After running forty-five days the meter was read and found to have registered a daily average of 13,008 gallons, or at the rate of 4,747.920 gallons per year, which is nearly one per cent. of the total annual pumpage, amounting in value, at the rate of 15 cents per 1000 gallons, to \$712.05. The annual water rent charged was \$85.56. The proprietor was notified, and after a persistent search of several days, a hole was found in the iron service under the basement floor, the water from which passed directly into the sewer. This leak was immediately repaired, since which time the meter has registered a daily average of 881 gallons, or an annual reduction of 4,426,355 gallons of water.

The present Board believe in pure water, and water in abundance, but not in the wasteful manner of use that exists in Lowell at the present time. A meter attached to each and every service, with exception previously alluded to, would certainly place all consumers upon a fair and equitable basis. A perfect meter does not exist. Some upon the market we are satisfied are worthless; others, with proper care, will render, with Merrimack River water, very accurate results. We can satisfy the most sceptical person of this fact. We mean to use none but the best, and are ever ready to try new inventions and improvements. At present we are placing the Crown in most cases. We have two others of recent arrival that we are running upon trial, determined, if any improvement or superiority is discovered, Lowell water takers shall be among the first to receive the benefits therefrom. Our experience leads us to declare as our opinion, and in this opinion former members of the Water Board coincide with us, that the time will come when every consumer will use metered water. Water rates can not be reduced so long as the department is compelled to furnish and properly distribute the quantity of water called for during certain periods of the year. Would not a universal meter system check the waste, reduce the running expenses, and postpone the necessity of increase of pipe capacity? Would it not actually reduce the cost of water to consumers? Here is a



question of public interest. We commend it to your thoughtful consideration.

#### CONDITION OF PLANT.

The Water Works plant is to-day in splendid condition. It will stand comparison with any water department in the country. Its employés are in the main men who are thoroughly acquainted with their work, are interested in the good name of the department, under superior discipline, all of which comes after years of continual service. We have now building new wagons for our work, to take the place of the dilapidated vehicles that have been seen upon our streets for too many years.

A break on the Morris engine during the month of October was the only mishap that occurred during the year of any serious consequence. In detailing what occurred and what has since been done in the way of repair upon the engine, we must presume upon your familiarity with the construction of the engine and pump. The break, or rather renewal of an old break, occurred in the sole-plate of the valve-chamber of the pump. In this plate were seated the seven 16-inch valves, through which all water drawn from the well by the Morris engine passed. The break of course compelled the entire shutting down of the engine. This occurred the 19th of October, since when until Dec. 19, the Worthington engine has furnished all the water for

the lower reservoir. The broken portions have been made good at a cost of \$1,388.34.

Before it was decided upon what should be done, Engineer E. B. Leavitt, of Cambridgeport, was consulted. He fully endorsed the plan as suggested by Engineer Roberts, and the work was commenced. In doing this repair work important changes have been made. The pump work heretofore performed is now accomplished by seven 9-inch valves seated in the sole-plate, placed at the base of the valve-chamber, re-inforced by ninety-nine 4-inch valves seated in the sides of the valve-chamber. So far the work following the changes is satisfactory, and reflects credit upon Mr. Roberts, who, with his assistants, devised and performed the work. In fact, it is a feature of the Lowell pumping plant. But for lack of time to make the change before winter's work should be upon us, it is not unlikely that we should have taken measures towards the rebuilding of the pump.

The present capacity of the Morris engine plant is 5,000,000 gallons in twenty-four hours. We believe that by an outlay of \$10,000 a new pump could be placed in position, and by speeding up the engine a capacity of 10,000,000 gallons could be obtained. Engineer Leavitt has been consulted upon this matter also. He says there is no doubt of the practicability of the scheme, and that without risk of injury to that noble machine, the Morris engine.

Here is certainly a ray of day-light on the problem of the future: How shall we increase the pumping capacity? It will be borne in mind that a new 5,000,000 engine would cost at least \$40,000, without providing location.

The repairs already done, or changes, as they might be properly termed, have entirely changed the character of the original Simpson pump. The features of this change are the first application upon any pumping engine, and as there is no duplicate of the Morris engine in this country, nor is there a likelihood of being, the patterns of the engine having been destroyed by fire, the future work of the engine will be watched with especial interest. In making these changes twelve tons of iron were removed from the well, replaced by three tons. The breakage simply came when the part affected had been worn out. Out of the accident, however, we believe, has come good; as by changed construction, explained, we have a more efficient engine than we had before the break occurred. Both engines are now in good condition and capable of full duty at any moment.

#### OUR FIRE SUPPLY.

The fire at Ayer City last year proved what had been feared, namely, that the water mains in that locality were inadequate to furnish water for a large fire. This portion of the city depended upon a

6-inch main running from the intersection of Carter and Gorham Streets, through Gorham and Lincoln Streets. This entire distance has, during the year, been replaced by 12-inch pipe. Two other large fires occurred during the winter at the city's center. It has been said that at both these fires there was a lack of water. The truth of such statements it is not our purpose to dispute. Determined, however, that it was our duty to increase the efficiency of the fire service of the city, after careful investigation, we recommended the introduction of six Lowry hydrants at different points at the city's center. We were met by an objection surprising to us, when we were told upon what grounds the objection was based,—the more, too, on account of the source whence it came. The department caused to be placed at the junction of Bridge and Merrimack Streets such a hydrant as recommended; gave an exhibition of what it was capable of doing before the city's officials, upon the result of which we have since been willing to rest our case. It was then shown, to any fair-minded person, that these hydrants at proper places, located directly on the mains, would furnish an inexhaustible supply of water, and at maximum pressure, no matter what the number of streams emitted. Since that time, on the petition of J. Tyler Stevens and other heavy property owners, one has been set at the intersection of Market and Central Streets. We presume



others will be asked for. We know no reason why such petitions should not be granted. We believe property at the center of the city will be more secure if they are used at points recommended.

#### A HEAVY OUTLAY.

From the Bodwell gate-house end of the Pawtucketville conduit, extending to and under Beaver Brook, thence to the pumping station, runs a 30-inch pipe, through which the entire city supply passes before entering the pump wells. Large as the discharge of this pipe is, it is not sufficient to supply the demand when extra calls for water are made. Our consumption is increasing rapidly, and for obvious reasons our capacity for supply must likewise increase. In our judgment, the first outlay in this direction will be that of re-enforcing the aforesaid 30-inch pipe. We should recommend the parallelling of the present 30-inch pipe with a second of the same size. This work, when undertaken, will be attended with difficulties, and will be expensive; nevertheless, it is work that can not be long delayed.

#### COAL AND IRON PIPE.

The following are the heavier purchases of the year:

OF D. W. HORNE & SON:

312 $\frac{1}{2}$  $\frac{1}{4}$  tons Cumberland coal, @ \$5.70.

**OF W. E. LIVINGSTON:**26 $\frac{1}{2}$ ~~248~~ tons Pocahontas coal, @ \$5.15.29 $\frac{3}{4}$ ~~240~~ tons Pocahontas coal, @ \$5.00.1500 tons Pocahontas coal (887 $\frac{3}{4}$ ~~240~~ delivered), @ \$4.75.**OF MELLERT IRON FOUNDRY:**

75 tons 6-inch cast-iron pipe, } @ \$31.60 per ton.

25 tons 8-inch cast-iron pipe, }

3 tons special castings, @ 2 $\frac{1}{2}$ c. per lb.**OF GLOUCESTER IRON WORKS:**

115 tons 12-inch cast-iron pipe, @ \$29.93 per ton.

14 pieces special castings, @ \$57.50 per ton.

**OF WARREN FOUNDRY:**

50 tons 6-inch cast-iron pipe, @ \$30.00 per ton.

50 tons 8-inch cast-iron pipe, @ \$29.60 per ton.

**OF R. D. WOOD & Co.:**

112 tons 10-inch cast-iron pipe, @ \$26.75.\*

**CONCLUSION.**

Concluding this report, we would acknowledge the faithful services of those in the employ of this department. Perfect harmony exists, so far as we are aware,—each and every one strives for the good of the department, and takes honest pride in his part of the responsibility. We believe the department is a credit to our city. Its efficiency can be increased, nevertheless.

We recommend the following matters to the consideration of the incoming Water Board: The continuation of the filtration investigation, valuable information concerning which is left by us for use; the placing of several Lowry hydrants at the center of the

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\* Price in Philadelphia.

city; the adoption of more stringent measures to prevent the existing enormous waste of water; a revision of water rates, thereby establishing a more equitable basis for the water charges; the pursual of such a course as shall encourage a more universal use of meters. Our desire before closing this report, and in connection with the last recommendation, is to anticipate an objection raised—a tendency to create disease by any effort to check waste of water. On this point the *Sanitary Engineer* says:

“But the ground is now taken that it is wrong to check waste, because the wasted water cleans the drains and sewers. This is nonsense; the continual dribble of a faucet does not clean out the drains. The emptying of a bath, a basin, or a water closet, does create a flush, which will remove obstacles; but the passage of ten times that amount of water, distributed over a long period, does not have that effect at all.”

The fact is that with a meter one may, as a rule, have all the water needed at a less figure than at annual fixture rates. This is the experience both in Europe and America. Therefore, while we do not at this time advise compulsory use of meters, we do recommend the offering of strong inducements for their voluntary use.

We would call the attention of the Water Board of 1889 to the fact that upon lower Middlesex, supposed to be supplied by a 12-inch main, there exists between Garnet and Jackson Streets a cut-in section of 8-inch main. That this circumstance exists, and has been permitted to exist for

so long a period, is a matter of surprise to us, as no doubt it will be to property owners in this crowded but valuable section of the city. We would recommend that in the spring of 1889 the first street work performed be the taking up of this 8-inch pipe and placing a 12-inch pipe in its place. The mere mention that such a condition of things exists, should bring speedy remedy.

The time is now near at hand (1890) when the water debt of the city can be refunded at a much lower rate of interest than at present. Of the \$108,045 paid as interest money during the past year, all, but interest amounting to \$3,315, is at the rate of six per cent. or higher. Here is a prospective saving, and an available surplus in sight, at least. It is reasonable for our citizens to expect some direct benefit from this reduction of interest, and the natural direction for it to come would be in the form of reduced water rates. Unless wasteful consumption or unforeseen disaster befalls, compelling the enlargement or repair of the works, and consequent outlay of money, a reduction of water rates will be a likelihood of the immediate future.

MILES F. BRENNAN,  
ARNOLD S. WELCH,  
HARRY E. SHAW,  
E. B. CONANT,  
E. D. HOLDEN.

The following Table will Show the Gross Cost of the Water Works Yearly, from the Commencement of the same to Jan. 1, 1889.

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Expended in 1870.....	\$ 95,057 00
“ 1871.....	624,151 66
“ 1872.....	560,708 40
“ 1873.....	349,717 87
“ 1874.....	233,370 63
“ 1875.....	275,660 78
“ 1876.....	221,502 24
“ 1877.....	163,814 28
“ 1878.....	158,510 15
“ 1879.....	150,047 82
“ 1880.....	154,391 59
“ 1881.....	231,171 27
“ 1882.....	173,645 92
“ 1883.....	180,280 28
“ 1884.....	175,290 20
“ 1885.....	176,972 56
“ 1886.....	169,105 22
“ 1887.....	176,906 05
“ 1888.....	183,279 73
<hr/>	
Gross cost of works to Jan. 1, 1889.....	\$4,453,583 47
Receipts to Jan. 1, 1889.....	2,070,187 01
<hr/>	
Net cost of works to Jan. 1, 1889.....	<u>\$2,383,396 46</u>

The following Table will Show the Expenditures and Receipts of the Works from 1873 to 1889, exclusive of Interest on the Water Debt.

	Expenditures.	Receipts.	Expenditures in excess of receipts.	Receipts in excess of expenditures.
1873.....	\$188,376 59	\$57,739 48	\$130,637 11	.
1874.....	128,105 63	80,625 65	47,479 98	.
1875.....	170,095 78	94,908 14	75,187 64	.
1876.....	115,012 24	98,815 54	16,196 70	.
1877.....	53,988 72	100,826 63	.....	\$46,837 91
1878.....	49,900 15	104,142 87	.....	54,242 72
1879.....	42,157 82	110,185 34	.....	68,027 52
1880.....	45,031 59	123,740 49	.....	78,708 90
1881.....	121,601 27	128,053 97	.....	6,452 70
1882.....	64,525 92	140,397 96	.....	75,872 04
1883.....	65,673 23	152,582 99	.....	86,909 76
1884.....	64,982 71	154,437 55	.....	89,454 84
1885.....	64,030 24	157,956 79	.....	93,926 55
1886.....	51,808 52	168,757 53	.....	116,949 01
1887.....	62,236 05	178,234 29	.....	115,998 24
1888.....	75,234 73	183,127 37	.....	107,892 64



# Charges for Water by Months, from Commencement to Dec. 31, 1888.

MONTHS.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.
January.....		\$ 363 94	\$ 418 96	\$ 150 45	\$ 126 51	\$ 169 14	\$ 282 44	\$ 233 73	\$ 182 58	\$ 233 37	\$ 271 52	\$ 472 70	\$ 702 05	\$ 410 21	\$ 427 60	\$ 454 33
February.....		35 53	235 43	238 85	86 84	144 38	238 19	349 08	146 40	139 22	136 06	347 66	332 90	439 68	439 98	343 66
March.....	\$6,124 94	50,200 10	65,417 68	82,249 51	89,177 52	82,225 43	80,603 69	80,567 44	89,210 88	90,866 37	94,966 65	98,692 13	102,061 30	104,337 77	111,281 68	110,812 26
April.....	785 89	1,739 50	935 20	265 34	584 11	1,970 12	9,242 84	6,478 39	540 20	403 64	263 10	351 73	439 64	1,355 01	773 67	536 02
May.....	2,988 16	3,274 09	2,147 96	874 47	1,819 65	1,121 43	2,751 35	1,476 15	879 61	1,191 41	984 84	1,495 90	1,062 34	1,760 48	2,057 80	1,750 52
June.....	5,818 78	2,895 86	2,887 43	4,460 91	2,359 52	3,903 69	6,126 86	868 08	12,574 12	16,401 62	17,767 44	18,709 27	21,203 61	23,768 43	23,017 09	26,090 68
July.....	4,833 52	1,889 03	1,926 31	582 68	3,147 78	1,261 24	1,213 13	11,457 84	273 00	959 80	1,059 37	899 21	1,053 36	1,434 96	2,383 37	1,781 40
August.....	2,728 30	498 50	449 86	771 87	799 88	677 01	563 35	459 17	514 46	634 40	902 76	984 17	828 40	1,173 44	927 65	1,072 41
September.....	2,827 07	3,245 06	865 90	495 97	3,493 90	4,998 07	6,584 86	8,168 23	10,088 19	10,904 30	12,467 32	12,939 94	13,452 97	16,105 05	18,397 55	16,773 25
October....	9,729 05	872 10	2,947 93	4,893 44	543 79	693 80	454 29	338 51	309 22	552 27	941 81	798 12	697 87	783 29	1,108 16	1,414 32
November.....	761 21	634 63	573 35	1,445 05	518 72	1,220 27	1,405 89	620 56	873 16	378 97	1,615 65	693 41	477 10	686 02	683 55	687 19
December.....	1,571 72	3,689 79	3,365 59	3,246 39	4,040 71	4,522 75	5,794 77	7,851 52	9,593 32	10,848 08	12,512 70	12,544 55	12,617 45	12,825 41	15,927 35	14,476 76
Totals.....	\$30,168 64	\$69,307 29	\$82,561 60	\$99,674 33	\$98,178 93	\$102,877 32	\$115,261 20	\$118,808 70	\$125,975 27	\$133,503 45	\$143,869 22	\$148,028 85	\$155,848 08	\$165,279 78	\$177,425 51	\$176,442 40
Less abatements to date.....		1,872 83	640 06	8,185 88	2,502 65	4,343 13	9,590 05	1,792 13	3,766 88	2,460 50	3,094 15	4,314 79	3,946 34	2,961 18	2,367 70	2,794 87
Net amts.....	\$30,168 64	\$67,434 50	\$82,221 54	\$91,489 05	\$95,676 28	\$98,534 19	\$105,671 15	\$117,106 58	\$122,208 39	\$131,012 95	\$140,775 07	\$144,614 06	\$151,902 64	\$162,288 60	\$175,057 81	\$173,647 53

\* A reduction of \$6,084.00 is accountable, owing to reduction of annual charge for fire hydrants.

# SUPERINTENDENT'S REPORT.





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\$183,139 37

\$188,523 96

183,279 73

\$5,244 23

General Expense.	Mechanical Filter Investiga- tion.	Water Analyses.	Salary President and Supt.	Total Expenditures.
\$ 68 44	.....	.....	\$166 66	\$ 2,504 91
157 28	.....	\$30 00	166 68	3,599 70
113 91	.....	.....	166 66	4,583 46
61 34	.....	.....	166 66	8,108 52
39 34	.....	.....	166 68	29,165 09
107 61	.....	.....	166 66	35,782 67
94 44	.....	.....	166 66	12,972 94
109 20	.....	40 00	166 68	5,879 88
27 73	\$423 50	20 00	166 66	7,751 01
98 74	.....	30 00	166 66	9,977 94
124 15	70 17	24 00	166 68	46,247 14
76 11	.....	.....	166 66	16,706 47
178 29	\$493 67	\$144 00	\$2,000 00	\$183,279 73

1888  
JAN 10  
NEW YORK

## REPORT OF THE SUPERINTENDENT.

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LOWELL, Jan. 1, 1889.

*To the Lowell Water Board:*

GENTLEMEN,— In accordance with the requirements of the City Ordinances, I herewith submit the Sixteenth Annual Report of the Superintendent of the Lowell Water Works, for the year ending Dec. 31, 1888, and in doing so it gives me great pleasure to report that every branch of the department is in good condition. The total consumption of water for the year is 1,823,089,224 U. S. gallons.

### FILTER INLET.

During the past year the filter inlet has been drawn off and cleaned several times, and the wooden box, 24 x 12, which conducted the water from the river to the inlet, has been removed, and a 12-inch cast-iron pipe, forty-eight feet in length, laid to do the work of this box, which was originally sixty feet long; but owing to its exposed condition to floating ice, it was all carried away but about ten feet, which was not long enough to prevent the sand on the river bank from washing into the end of the box and completely clogging it up so as to prevent the passage of any water to the filter. This 12-inch pipe was laid running obliquely down stream, with a 12-inch gate on the bank, and a 2-inch plank placed under the end of the pipe in the river to prevent it from becoming imbedded

in the bottom. This pipe has proved a great improvement over the wooden box, inasmuch as it is perfectly tight, and by using the gate the supply can be shut off without any trouble. It is also laid at a greater depth, so much so that during the dryest part of the summer the pipe was entirely under water.

The first cleaning of the inlet was begun May 28th. On the bottom of the basin was found a coating of river silt, varying from two to three feet deep and covering all parts of the filter bed, making it absolutely impervious to water. This silt was wheeled off in barrows and dumped on the river bank below the inlet. When the top layer of the old sand was raked over it was found best to remove a considerable portion of it, after which a layer of fresh sand was spread about two inches deep over the entire surface of the bed. The cost of this first cleaning, including labor, tools, and material, was \$167.81; and laying 12-inch pipe and gate, cost of pipe and digging included, was \$114.00, making a total of \$281.81. That this large expenditure for cleaning would not be necessary, had the inlet been attended to in former years as it has been this, is borne out by the fact that every time it was cleaned subsequently the expense did not exceed \$6.75.

After the first cleaning was completed, June 3d, the river gate, that is, the gate controlling the supply direct from the river, was closed, and the 12-inch gate on the new inlet-pipe was opened, letting the water on to the filter bed. When this gate had been open about two hours the Morris engine was started, and for twenty-four hours all of the water pumped into the reservoir, which was 5,280,000 gallons, was supplied by the filter inlet and gallery. At the end of twenty-four hours the water in the pump wells became so low that it was found

necessary to open the river gate one inch, and after a few days it was opened still more, but at no time was this gate opened more than three inches until the filter bed was again cleaned, when a similar result was obtained. Taking into consideration that previous to this time it was always necessary to keep the river gate open at least six inches, it is easy to account in a measure for the improvement in the quality of our water supply the past summer. The inlet was cleaned in all five times, viz: May 28th, June 25th, July 14th, Aug. 13th, and Sept. 14th. Soon after this last date the unusually heavy and almost constant rains had so swollen the river as to cause it to overflow the river banks of the inlet, making it impossible to empty the basin for the purpose of cleaning, and also washing silt, mud, and other matter over the banks, thereby completely preventing any filtration. You can see, by this condition of affairs, that if the river side of this inlet was as high as the other sides, this trouble from high water would not exist, and it could have been cleaned every month up to the present time, and a large percentage of the water in use filtered.

#### GALLERY AND CONDUIT.

The 30-inch blow-off gate on the conduit was opened May 28th, and allowed to remain so until the next day, during which time the river gate was let on full head, in order to give both the gallery and conduit a thorough blowing-off. Next year, the gallery should be pumped as dry as possible, and then washed and cleaned; also, a careful inspection should be made of the brick conduit.

#### PUMPING STATION.

The change in the valve chamber of the Morris engine has been completed, under the direction of Engi-

neer Roberts, and the engine is now running every day. Since this change has been made, it is safe to say that the engines at the pumping station were never in better condition than they are at present.

The boilers were all thoroughly cleaned this year, and a new set of tubes placed in No. 3 boiler. A new set of grates was also set for No. 1 boiler. The pump wells have been cleaned out and scrubbed three times during the year.

The brick piers and masonry under the force main, which leads from the Morris engine, through an arch, to the outside of the building, were found to have fallen away, so as to leave the pipe with scarcely any support. This was attended to, and the old piers were rebuilt, besides adding three new piers and otherwise bracing it, so as to make it secure for years to come.

Everything in connection with the pumping machinery of the department is in first-class condition, and Mr. James P. Roberts and his assistants deserve credit for the earnest and faithful manner in which they performed their duties.

The total pumping by the two engines is 1,822,042,490 gallons, which is an increase of 243,049,890 gallons over last year, and 137,369,960 gallons more than the corresponding increase of 1887. The high-service engine has pumped this year 23,468,466 gallons: an increase of 2,658,068 gallons over 1887. This is greatly in excess of the increase for 1887 over 1886, which was only 557,676 gallons.

#### RESERVOIR.

The grounds at the lower reservoir have received considerable attention this year. The grounds on the south and east sides of the house have been filled, to make a gradual slope from the house, then sodded. A concrete

walk has been laid from the house to the driveway, and from Richards Street to the front steps of the house. The driveway, which had been allowed to grow into disuse, was spaded over, regraded, and otherwise improved. The fence on the northerly side of the reservoir lot had to be moved thirty-four feet towards the south, to conform to the lines of Richards Street, — a new street laid out by the government of 1887. The posts of the fence to be moved were found decayed to such an extent that more than one-half of them had to be replaced. Two new gates were set in this fence on Richards Street: one large one for the stable, and a smaller one for the entrance to the house. No repairs have been made on the house this year; and as it is in good condition, none will be needed the coming year. Next year the large fence should be repainted. The stock was purchased this year, with a view of doing this painting, but as it was late in the fall it was deemed advisable to postpone it until next year. The screens in the efflux chamber of the gate house were taken out and cleaned, last month. Mr. Frank Lapoint, the man in charge of the reservoir, has been untiring in his efforts to make the grounds as neat and attractive as possible, as everybody visiting the reservoir can testify. The high-service reservoir grounds are kept closed all the time, and require little attention.

#### EXTENSIONS.

During the past year there has been laid 17,484 feet of cast-iron pipe, 3,385 feet of which was relaid on Gorham and Lincoln Streets, leaving the total number of feet added to the distributing mains of the city this year 14,099, making 4,983 feet more than was added last year. 2,411 feet were added to the high-service mains of the city this year, which was called for by the opening



up of that section of Tewksbury recently annexed to Lowell. To accommodate the needs of this locality, the 6-inch high-service line on Fairmount Street was extended to Laurel Street, and through Laurel Street to Hanover Avenue and Parkview Avenue, and also a considerable distance on both of those streets. On Hanover Avenue a 6-inch gate was placed, so that at some future time this line might be connected with the low-service main which is laid in the other end of this avenue, and the high service shut off at this gate.

In past years 6-inch pipe was the size generally laid. This year, however, there was laid on Stevens Street 1,911 feet of 8-inch pipe, and on Tanner Street 1,296 feet 10-inch pipe. This extension on Tanner Street was very much needed, as the supply of water was entirely insufficient for fire purposes.

Nineteen new stop gates have been set on extensions this year, all of which, together with the location of pipe extended, is given in detail, in table form, further on.

#### GORHAM AND LINCOLN STREETS.

In addition to the regular work of extending main pipe, acting under your instructions the 6-inch main pipe on Gorham Street, beginning at the terminus of the 12-inch main opposite Carter Street and extending southerly to Lincoln Street, through Lincoln Street to Tanner, was taken up and replaced by extending the 12-inch main. The distance covered by this work was 766 feet on Gorham and 2,619 feet on Lincoln Street. The work was begun July 16th and completed Aug. 9th, and although the water had to be shut off in that section of the city a number of times, and all the services re-connected, yet no complaints were heard of any inconvenience suffered from this cause. The old

pipe was taken up by cutting the pipe every four lengths and hoisting these lengths out of the ditch all connected, then melting the joints in order to separate them. By this means the department was able to save all of the special castings and about three thousand feet of the old pipe, which was laid again in other streets. In connection with this work an additional gate was placed on the 6-inch main at the present terminus of 12-inch line on Gorham Street. This enables the shutting off of the water beyond this point on Gorham Street without interfering with the supply on Lincoln Street.

#### HYDRANTS.

Twenty-four new hydrants have been added this year, which is more than has been added any one year for the last eight years. Flush hydrants have been changed for post hydrants, as follows: Summer Street, near Gorham; Gorham Street, near Livingston, and Lincoln Street, near Gorham. The Ludlow post hydrant, on Beacon Street, near Sixth, was found entirely broken off above the valve, and was replaced by a Boston post hydrant. Numerous other hydrants have been repaired during the year, mostly cases where the spindle was turned too hard and bent. In the severest part of last winter six hydrants were frozen and had to be thawed. The flush hydrant at the corner of Tanner and Lincoln Streets has been taken out and replaced by a 6-inch post hydrant, with four outlets, and an 8-inch connection, making it the largest post hydrant in the city. As you are aware, two large Lowry hydrants have been set by the department the past year: the first was set at the intersection of the Merrimack and Bridge Street 12-inch main lines, at a point where, if necessary, the water could be supplied directly from the pumps; the second was set

on the 16-inch main on Market, near Central Street. These hydrants, all connected and ready for use, cost less than the common post hydrant, for the simple reason that less pipe is required, and consequently less digging. It should be the object of the department in the future to favor larger hydrants and larger mains.

#### SERVICES.

Three hundred and thirty-six services have been laid this year, or about the same number as last year. The number of feet of new service pipe laid this year is 11,305 feet, as against 11,956 feet last year. The number of services changed this year is 204, or 7,991 feet, against 157, or 5,650 feet in 1887, which shows, as predicted last year, that eventually all of the wrought-iron service pipe in the city would have to be replaced by lead pipe, or larger iron. In view of this fact, it would seem that the time has come for your Board to establish a rule that all service pipes hereafter applied for, not larger than one inch in diameter, should be of lead pipe. During the very cold spell last February, several service pipes on Merrimack, Middlesex, and Appleton Streets were found frozen near the street mains, and, in all cases, under the horse railroad tracks, showing that the removal of the snow from these tracks allowed the frost to penetrate more readily into the ground, thereby freezing the pipes. All of these frozen services were thawed out, and the people given water as soon as possible. This thawing was done by pumping hot water through a block-tin tubing, one-fourth of an inch diameter, into the service pipe to the ice, and continuing to pump in this manner until the water came with its usual force. After these services were once thawed, it was thought best to allow the water to continue to run constantly, to

prevent further freezing. If this should occur every winter it would undoubtedly be economy to lower the pipes in these streets. 126 services have been shut off for non-payment; 3 remitted, 95 paid, 28 remain unpaid.

The amount of service pipe laid in 1888 is as follows :

$\frac{5}{8}$ -inch lead pipe.....	5,579 feet.
$\frac{3}{4}$ -inch lead pipe.....	3,172 "
1-inch lead pipe.....	1,189 "
$\frac{3}{4}$ -inch wrought-iron pipe.....	51 "
1-inch wrought-iron pipe.....	753 "
$1\frac{1}{2}$ -inch wrought-iron pipe.....	135 "
2-inch wrought-iron pipe.....	407 "
$2\frac{1}{2}$ -inch wrought-iron pipe.....	19 "
<hr/>	
Total laid during 1888.....	11,305 "
Amount previously laid.....	287,774 "
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Total amount now laid .....	299,079 "

Or 56 miles 3,399 feet.

Total number of services put in.....	8,115
Total cut off at main.....	384
Total re-connected .....	23
Total now in use.....	7,755

### Number and Kind of Services Changed During the Year 1888.

SIZE OF SERVICE CHANGED FOR.		$\frac{1}{2}$ inch lead.	$\frac{3}{4}$ inch lead.	1 inch lead.	1 inch iron.	$1\frac{1}{2}$ in. iron.	2 inch iron.	Number Feet.
59	$\frac{3}{4}$ inch iron.....	2230	....	....	....	....	....	2230
81	$\frac{3}{4}$ inch iron.....	....	3322	....	....	....	....	3322
48	$\frac{3}{4}$ inch iron.....	....	....	1661	....	....	....	1661
3	1 inch iron.....	....	....	343	....	....	....	343
3	$\frac{3}{4}$ inch iron.....	....	....	....	198	....	....	198
1	$\frac{3}{4}$ inch iron.....	....	....	....	....	62	....	62
3	$\frac{3}{4}$ inch iron.....	....	....	....	....	....	92	92
6	1 inch iron.....	....	....	....	....	....	83	83
<hr/>		<hr/>						
204	Total.....	2230	3322	2004	198	62	175	7991



## Schedule of Small Pipe Laid.

STREETS.	1 inch.	1½ inch.	2 inch.	Total feet.
Blodgett .....	....	....	124	124
Brown's court, relaid.....	....	111	....	111
Crescent.....	....	....	258	258
Common .....	....	60	....	60
Cheney avenue, relaid.....	....	....	142	142
Cheever.....	....	84	....	84
Horne, relaid.....	....	110	....	110
Gove .....	....	75	....	75
Leavitt avenue.....	....	....	152	152
Olive, annex .....	....	160	....	160
River, off.....	....	138	....	138
Robinson's court .....	....	....	138	138
Richmond avenue.....	....	117	....	117
Second avenue, relaid.....	....	117	....	117
Sawtelle place.....	....	....	168	168
Tanner, off.....	....	234	....	234
Viles .....	....	114	....	114
West.....	55	....	....	55
Total .....	55	1320	982	2357

There are now in use 1,630 meters, an increase over last year of 100. New meters set during the year, 103, an increase over last year of 21. Meters discontinued this year, 3; meters taken out and others set in their places, 49; meters taken out for repairs, 367; meters destroyed by freezing, 19; tops burst on Crown meters by freezing, 10; Worthington meters cleaned and repaired, 71; Desper meters repaired at pumping station, 162.

It will be seen by the above figures that the severe cold of last winter had its effect on the meters as well as the services. More meters were frozen last year than have been frozen altogether since the works were established.

### Meters Running Jan. 1, 1889.

SIZE IN INCHES	$\frac{1}{8}$ in.	$\frac{1}{4}$ in.	1 in.	1 $\frac{1}{4}$ in.	2 in.	3 in.	4 in.	Motor Register.	Total.
Desper.....	493	149	67	1	....	....	....	....	710
Worthington .	270	25	49	69	25	7	2	....	447
Crown.....	158	154	77	1	6	....	1	....	397
Duplex.....	13	14	9	....	....	....	....	....	36
Ball & Fitts..	17	8	2	1	....	....	....	....	28
Fitts Rotary..	4	1	....	....	....	....	....	....	5
Motor Register	....	....	....	....	....	....	....	6	6
Balance Valve.	....	1	....	....	....	....	....	....	1
Total .....	955	352	204	72	31	7	3	6	1630

### LEAKS.

There has been during the past year an unusual number of leaks in service pipes, caused in most instances by men outside the department, who unlawfully take the liberty of turning on water. These men, as a general thing, are either very careless, or they do not understand the way these cocks should be turned, and as a consequence the cocks are wrenched and broken, and a leak is reported, which would not have happened if they called upon the department to do this work. Another cause of leaks is the effect of cinders on wrought-iron pipe. Very frequently a pipe laid through ground made

of cinders and ashes is found entirely perforated, so as to leak.

The 12-inch main pipe on Central bridge was discovered leaking, last October. Upon examination, six of the joints were found with the lead partly drawn out, caused probably by the failure of the expansion joints to work as intended. After recalking and tightening up these joints, the water was turned off for the winter, and the water in the pipe drawn off. Four other leaks occurred in large mains, which were merely the result of the leading blowing out of joints, caused by water hammer, or by the settling of the ground under the pipes. On Gorham Street, where W. H. Ward was building a sewer for the city, a culvert broke away during a heavy rain and washed the earth from under the water pipe, causing it to leak. No leaks have occurred which caused any damage to property during the year.

#### MISCELLANEOUS.

Three new 4-inch fire services have been applied for and laid the past year.

The main pipe on the Mammoth Road had to be lowered near the Old Meadow Road, owing to a change in the grade at that point of the road; also, one hydrant had to be lowered, and one raised, to conform with this change of grade.

The city mains were blown out on May 28th. All of the ten blow-off gates in the city were opened at the same time. At first the water came very black, but after about an hour it began to run itself clear, and at the end of two hours the water was perfectly clear.

A new 30-inch pipe drinking fountain was set on Rogers Street, at the entrance to Fort Hill Park.

## CONCLUSION.

In conclusion, the department is to be congratulated upon having the services of such an able and efficient clerk as Charles L. Knapp has proved to be the past year. Too much can not be said in his praise, for the ability he has displayed in managing the collections of the department, and for the faithful manner in which he has attended to all the details of the office. I most cordially extend to him my thanks for the assistance he has rendered me, and also I beg leave to return my thanks to your honorable board for your co-operation during the year. In regard to the employees in general, they have done faithful service.

Respectfully submitted,

ROBERT J. THOMAS,

*Superintendent.*



## Low Service — Water Pipes Laid in 1888.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.					
		4-in.	6-in.	8-in.	10-in.	12-in.	Total.
A .....	Westerly to So. Walker.....	....	82	....	....	....	82
Abbott.....	To connect with Central.....	122	....	....	....	....	122
Agawam.....	To connect with Moore.....	....	136	....	....	....	136
Andover.....	Easterly from Hanover av.....	....	91	....	....	....	91
B .....	West of Powell; extended.....	....	35	....	....	....	35
Blossom.....	Extended westerly.....	....	170	....	....	....	170
Bourne.....	Northerly from Moore.....	....	183	....	....	....	183
Earl.....	Southerly from Fay.....	84	....	....	....	....	84
Fay .....	O'Connell and Earl.....	115	....	....	....	....	115
Foster .....	Extended southerly.....	....	258	....	....	....	258
Frye .....	Southerly to Hubbard.....	....	31	....	....	....	31
*Gorham .....	Carter and Lincoln.....	....	....	....	....	766	766
Hall.....	Tremont and Tilden.....	....	122	....	....	....	122
Hall.....	Tucker, north-westerly.....	....	....	144	....	....	144
Hanover .....	To connect Moody.....	....	20	....	....	....	20
Hanover av..	Southerly from Andover.....	....	763	....	....	....	763
Hubbard .....	Westerly from Frye..	....	116	....	....	....	116
John .....	Paige and French.....	....	106	....	....	....	106
Lawson .....	Extended westerly.....	39	....	....	....	....	39
Liberty .....	Westerly to Warwick.....	....	121	....	....	....	121
*Lincoln .....	Gorham and Tanner.....	....	....	....	....	2,619	2,619
Madison .....	Burns and Thorndike.....	....	319	....	....	....	319
Manchester ..	Court and Quebec.....	....	121	....	....	....	121
Mason .....	Westerly to So. Walker.....	....	134	....	....	....	134
Mason .....	Easterly from Hastings.....	....	255	....	....	....	255
Middlesex .....	Range and Wood.....	....	....	370	....	....	370
Moody .....	Tremont and Hanover.....	....	249	....	....	....	249
New School...	South of Mason; extended.....	....	141	....	....	....	141
Parker.....	Easterly to Avery Marshall's.....	....	36	....	....	....	36
Parker.....	Westerly from Powell.....	....	186	....	....	....	186
Pleasant.....	Extended southerly.....	....	46	....	....	....	46
Range .....	Southerly from Middlesex.....	....	566	....	....	....	566
Sawtelle pl..	Extended westerly.....	....	125	....	....	....	125
Sherman.....	Easterly from Concord.....	....	134	....	....	....	134
So. Walker...	Southerly from Mason.....	....	349	....	....	....	349
	Carried forward.....	390	4,895	514	000	3,385	9,134

**Low Service—Water Pipes Laid in 1888 (continued).**

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.					
		4-in.	6-in.	8-in.	10-in.	12-in.	Total.
	<i>Brought forward</i> .....	300	4,805	514	000	3,385	9,154
So. Walker...	Northerly from A.....		37	....	....	....	37
So. Whipple..	Northerly from Griffin, to connect....		316	....	....	....	316
So. Whipple..	South of Barrington; extended....		51	....	....	....	51
So. Wilder....	Extended southerly.....		402	....	....	....	402
Stevens .....	Extended southerly to Forrest....		...	1,911	....	....	1,911
St. Hyacinthe,	Extended southerly.....		103	....	....	....	103
Tanner .....	At glue factory.....		7	....	....	....	7
Tanner .....	Lincoln and R. Dobbins' shop....		....	....	1,296	....	1,296
Varnum av...	Extended westerly.....		606	....	....	....	606
Ward.....	Extended north-westerly.....		35	....	....	....	35
Warwick ....	Southerly from Liberty.....		534	....	....	....	534
Washington..	Extended southerly.....		114	....	....	....	114
Watson av..	Extended easterly.....		26	....	....	....	26
Windsor .....	Northerly from Westford.....		285	....	....	....	285
	Hydrants.....		196	....	....	....	196
Laid in 1888.....		367	7,000	2,425	1,296	3,385	15,073
*Less 6-inch pipe taken out.....		....	....	....	....	....	3,385
Low Service laid previous to 1888.....		....	....	....	....	....	11,688
Total Low Service to Jan. 1, 1889.....		....	....	....	....	....	422,304
Total High Service to Jan. 1, 1889.....		....	....	....	....	....	433,992
Total High and Low Service to Jan. 1, 1889.....		....	....	....	....	....	18,458
Total in miles.....		....	....	....	....	....	452,450
Total in miles.....		85.69.					

**High Service—Water Pipes Laid in 1888.**

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.
		6-inch.
Fairmount .....	Southerly to Laurel.....	351
Hanover avenue.....	Northerly from Laurel.....	549
Laurel .....	Fairmount, easterly.....	1,039
Parkview avenue....	Northerly from Laurel.....	450
	Hydrants .....	22
	Totals .....	2,411
	High Service laid previous to 1888.....	16,047
	Total High Service to Jan. 1, 1889.....	18,458



**Low Service—List of Stop Gates Set During the Year 1888.**

STREETS.	LOCATION.	4-inch.	6-inch.	10-inch.	12-inch.
Abbott.....	10 ft. west of east line Abbott, 2.4 ft. south of south line Central.....	1			
Agawam.....	13 ft. east of west line Agawam, 2 ft. north of north line Moore.....		1		
Bourne.....	12 ft. east of west line Bourne, 2.5 ft. north of north line Moore.....		1		
Gorham.....	21 ft. east of west line Gorham, 21 ft. south of north line Lincoln.....		1		
Hall.....	18 ft. north of brick block south side Hall, 1.7 ft. east of west end brick block.....		1		
Hanover avenue.	13.3 ft. east of west line Hanover avenue, on south line Andover.....		1		
Lincoln.....	15 ft. south of north line Lincoln, 2.6 ft. west of east line Gorham.....				1
Lincoln.....	16 ft. north of south line Lincoln, 16 ft. east of east rail O. C. R. R.....				1
Lincoln.....	18 ft. north of south line Lincoln, 116 ft. east of River Meadow brook.....		1		
Lincoln..... (Fire Service).	9 ft. northeast of southwest line Lincoln, 118 ft. south of brook.....	1			
Mason.....	10.4 ft. south of north line Mason, 3.7 ft. east of east line Hastings.....		1		
Mason.....	14.5 ft. south of north line Mason, 2.8 ft. west of east line South Walker.....		1		
O. C. R. R.....	Near Lincoln street, on stand-pipe line.....		1		
Parker.....	13.6 ft. south of north line Parker, 6 ft. west of west line Powell.....		1		
Range.....	10.4 ft. west of east line Range, on southerly line Middlesex.....		1		
Sherman.....	12 ft. south of north line Sherman, on easterly line Concord.....		1		
Tanner.....	21.6 ft. northwest of Tannery, southeast side Tanner, about on southwest line of Tannery....			1	
Varnum avenue.	28 ft. north of south line Varnum avenue, 3 ft. west of post hydrant at Thomas Varnum's...		1		
Walker, (Fire Service, L. S. S. Co.)	36.5 ft. east of west line Walker, 115 ft. north of north rail R. R.....	1			
Warwick.....	25.5 ft. east of west line Warwick, 4 ft. south of south line Liberty.....		1		
Windsor.....	9.3 ft. east of west line Windsor, 2.5 ft. south of north line Westford.....		1		
J. L. Cheney & Son (Fire Service).	3.5 ft. east of east line School, 16.4 ft. north of building south side of street.....	1			
<b>High Service.</b>					
Hanover avenue.	13 ft. east of west line Hanover avenue, on northerly line Laurel.....		1		
Laurel.....	25.7 ft. north of south line Laurel, on easterly line Fairmount.....		1		
Parkview avenue	16 ft. east of west line Parkview, about on north line Laurel.....		1		



## Property at the Pipe Yard, Jan. 1, 1889.

## SCHEDULE OF PIPE AND SPECIAL CASTINGS.

DIAMETER IN INCHES.	4	6	8	10	12	16	20	24	30
Lengths.....	3	112	53	24	13	5	17	8	4
Sleeves.....	1	8	6	5	....	9	5	9	7
Caps.....	12	5	21	8	16	3	1	1	....
Curves.....	4	4	12	2	8	4	10	3	....
Plugs.....	11	5	7	....	....	....	....	....	....

DIAMETER IN INCHES.	4 x 4	6 x 4	8 x 6	10 x 6	10 x 8	12 x 6	12 x 8	12 x 10	12 x 12	16 x 6	16 x 8	16 x 12	16 x 16	6 x 6	8 x 8
4-ways.....	7	3	4	2	1	5	5	1	1	2	1	2	1	4	1
3-ways.....	7	2	5	1	1	4	1	1	1	1	1	1	1	1	1
Reducers.....	7	2	5	1	1	4	1	1	1	1	1	1	1	1	1

Stop gates, 9 4-inch, 4 6-inch; wrought-iron pipe, 60 feet 1½-inch, 10 feet 2-inch; 1½ reels of ½ lead pipe, 2 reels and 40 feet ¾-inch, 1 reel of 1-inch; 6 ¾-inch tees; 15 1x½-inch, 8 1x½-inch crosses; 20 1-inch, 20 1x1½-inch elbows; 10 1x½-inch, 20 1½-inch iron unions; 12 2-inch, 6 2x1½-inch bushings; 20 reducing couplings; 15 1-inch plugs; 70 ½ solder nipples; 16 1-inch, 82 1-inch sidewalk cocks for iron, 6 1-inch sidewalk cocks for lead, 63 1-inch cellar cocks, 50 ¾-inch sidewalk cocks for iron, 48 1-inch corporation cocks, 53 ½-inch corporation cocks; 10 ¾-inch unions; 3 1-inch brass bushings; 80 ¾-inch brass nipples, 20 1½ inch solder nipples; 73 ½-inch cellar cocks, 41 ½-inch sidewalk cocks; 15 ¾-inch solder nipples; 18 ¾-inch brass plugs; 3 1x¾-inch brass tees, 15 ¾-inch brass tees; 20 ½-inch plugs; 4 1½-inch solder nipples; 32 ¾-inch unions; 3 iron hydrant boxes, 1 hydrant box, wood, 15 iron sidewalk boxes; 6 joints of earthen pipe for sidewalk boxes, 2 buck saws, 2 saw horses, 1 machine for testing pipe, 2 pipe benches, 2 tool boxes, 3 derricks, 36 square collars, 36 rings for sidewalk boxes, 2 fall ropes, 2 set blocks, 6 draught chains, 14 wheelbarrows, 2 tongs for cleaning sidewalk boxes, 4 hydrant frames, 8 hydrant covers, 6 gate-box frames, 6 gate-box covers, 1 drinking fountain, 30 picks, 20 pick handles, 15 round-point shovels, 15 square-point shovels, 6 scrub brooms, 4 hand brushes, 9 pair rubber boots, 6 lanterns, 30 feet rubber hose, 1 hose reel, 2 brass goosenecks, 6 calking sets, 4 nail hammers, 100 sidewalk box caps, 200 feet canvas hose, 300 feet 2½-inch rubber hose, 30 iron lug straps, 250 lbs. assorted bolts, 6 assorted files, 12 assorted gravel screens, 2 lbs. cotton waste, 3 trowels, 10 lbs. iron washers, 30 lbs. assorted nuts, 3 hand hatchets, 1 axe, 5 sling ropes, 1 dualin pot, 9 striking hammers, 4 hand hammers, 3 paving hammers, 500 lbs. pig lead, sets old blocks, 2 lead pots, furnace for melting lead, 1 zinc pump, 3 copper force-pumps, ½ keg 30d nails, ½ keg 10d nails, 40 assorted wrenches, 9 rammers, 3 paving mauls, ½ barrel cement, 10 lbs. white clay, 1 snow shovel, 1 blacksmith shop, 1 work shop, 1 carriage house, 1 stable, 1 store shed, 3 spirit levels, 500 feet lumber, 2 patterns for making gate and hydrant boxes, 1 set blacksmith tools, 300 lbs. steel in drills, 4 scrapers for blasting purposes, 4 lbs. pipe

wedges, 3 yarning irons, 3 lead ladles, 6 crow bars, 4 horses, 5 express wagons, 1 light wagon, 1 single truck, 1 double truck, 4 horse blankets, 4 street horse blankets, 1 buffalo robe, 1 duster, 2 pungs, 1 sleigh, 3 horse brushes, 7 single harnesses, 1 double harness, 12 1-inch lead connections, 4 2-inch, 4 halters, 4 hay forks, 2 manure forks, 2 wagon jacks, 2 wagon wrenches, 2 canvas covers for horses, 3 tons of hay, 2 post hydrants, 15 old style second-hand hydrants, 2 flush hydrants, 12 pipe tongs, 5 Stilson wrenches, 6 monkey wrenches, 4 tapping machines, 20 dippers for drinking fountains, 125 feet black-tin tubing, 1 30-foot extension ladder, 2 24-foot ladders, 2 ratchet cutters, 3 pipe cutters, 20 dies, 2 ratchet die plates, 1  $\frac{3}{4}$ -inch tap, 1 1-inch tap, 1  $1\frac{1}{2}$ -inch tap, 1 2-inch tap, 75 feet black-tin wire, 1 solder pot, 2 solder moulds, 2 charcoal furnaces, 1 naphtha furnace, 5 soldering irons, 19 gate spindles, 2 disks, 10 hydrant spindles, 28 hydrant valves, 10 hoes, 30 hydrant packings for top, 34 for bottom, 68 assorted hydrant packings, 10 packings for 4-inch gate, 12 for 6-inch, 6 for 8-inch, 3 for 12-inch, 1 for 16-inch, 1 map distributing mains, 1 map showing stop-gates, 1 map of Lowell, 1 ton stove coal, 2 portable closets,  $\frac{1}{2}$  gross of lamp wicks, 1 blasting battery, 1 desk, 10 lbs. of dualin, 11 S curves, 1 pattern for S curves, 85 lengths of second-hand cement-lined pipe, 2 stone hammers,  $\frac{1}{2}$  ton blacksmith coal, 10 lbs. of plumber's solder, 3 paint brushes, 3 paint pots, 1 marlin spike, 6 lights of window glass, 10 lbs. of calking yarn, 20 logs for blasting purposes, 1 10-gallon can, 1 Edison patent pump, 12 feet 4-inch rubber hose, 1 5-gallon can, 2  $\frac{1}{2}$  gallon, 1  $\frac{1}{4}$  gallon, 1 sieve and cover, 1 coal stove, 1 coal hod, 2 brooms, 1 counter scales, 1 platform scales, 1 clock, 2 pipe vises, 2 screw drivers, 2 mallets, 1 foot lathe, 1 lathe dog, 2 bit stocks, 2 bits, 1 2-inch auger, 5 hand saws, 1 washer cutter, 1 bench block, 1 fore plane, 1 set of numbers, 1 directory, 8 galvanized iron pails, 3 chairs, 100 lbs. of scrap leather for washers, 1 iron kettle, 1 hose nozzle, 1 thermometer, 2 lbs. of screws, 1 gallon of castor oil, 1  $1\frac{1}{2}$ -inch Chapman valve, 5 window curtains, 2 lbs. of rosin, 1 pair of snips, 1 tool box, 50  $\frac{3}{8}$ -inch lead connections, 15 1-inch lead connections, 6 hammer handles, 6 1-inch Crown meters, 3  $\frac{3}{4}$ -inch, 10  $\frac{5}{8}$ -inch, 5 tops for 1-inch Crown meters, 3 for  $\frac{3}{4}$ -inch, 1 for  $\frac{5}{8}$ -inch, 12 tops for Worthington meters, 25 covers, 12 valves and valve seats, 20 spindles for Worthington meters, 12 out and inlet connections for Desper meters, 10 lead connections for Worthington meters, 3 set packing patterns, 1 roll of packing paper, 2 lbs. of sealing wax,  $\frac{1}{2}$  box crayons, 1 brass lamp, 1 leather tool bag, 1 pair pliers, 200 brass unions for  $\frac{3}{8}$ -inch meters, 6 brass nipples and unions, 6 brass unions for  $1\frac{1}{2}$ -inch meters, 6 brass unions for 2-inch meters, 1 pail and tank for testing meters.

### Property and Tools at Reservoir.

1 line hose, 1 hose reel, 1 lantern, 1 monkey-wrench, 2 wheelbarrows, 2 long-handle spades, 2 long-handle round-pointed shovels, 1 scythe, 1 snath, 1 wooden rake, 1 iron rake, 1 pitch-fork, 1 lawn-mower, 1 grass hook, 1 square-blade shovel, 5 round-point shovels, 2 picks, 2

short handles, 2 crow bars, 1 hammer, 1 broom, 1 snow-shovel, 1 barrel linseed oil, 1 stove, 1 sod-cutter, 1 sidewalk wrench, 1 stop-gate wrench, 1 ice chisel, 1 nail hammer, 1 saw, 2 chairs, 1 sectional ladder, 1 dwelling house, 1 stable.

### **Tools and Property at Filter Inlet.**

2 iron-tooth rakes, 8 shovels, 2 ice chisels, 1 ice rake, 1 pick, 2 stop-gate wrenches, 1 broom, 2 wheelbarrows, 1 boat, 3 oars, 3 hoes, 1 dip net, 1 pail, 1 oil-can, 1 quart lubricating oil, 1 pike pole, 1 sidewalk wrench, 1 set blocks and rope, 50 feet rubber hose.

### **Property and Tools at Pumping Station.**

1 pipe vise, 1 work bench, 1 portable forge, 8 sets brasses for engine, 2 sets differential blocks, 100 feet 2-inch rope, 1 set fire irons, 1 brass hydrant, 1 axe, 11 finished wrenches, 3 hand-saws, 2 jack-screws, 10 cold chisels, 2 ratchet drills, 1 socket drill, 4 calking chisels, 1 barometer, 2 thermometers, 1 office desk, 2 indicators, 1 oil cupboard, 2 oil dishes, 1 platform scale, 4 crow bars, 64 feet  $\frac{3}{4}$ -inch iron chain, 16 eye-bolts, 1 truck, 1 key-wrench for air pump, 2 iron wheelbarrows, 1 buck saw, 2 gas tongs, 2 gas lamps, 1 high-grade thermometer, 4 brass bolts, 11 wrenches for Morris engine, 11 for Worthington, 3 sledge hammers, 10 drills (assorted sizes), 5 bitstocks, 125-foot ladder, 120-foot, 118-foot, 1 pair steps, 1 hoe, 2 rakes, 1 small die plate, 1 fore plane, 6 monkey-wrenches, 1 piece 2-inch rope, 3 chisel bars, 4 small taps, 4 socket-wrenches, 2 14-quart iron pails, 4 hand hammers, 1 grindstone, 1 anvil, 7 gas tongs, 1 hydrant wrench, 2 clocks, 1 full set dies (from 1-inch to 2-inch, right and left), 2 die-stocks and bushings, 2 sets blocks (3 $\frac{1}{2}$ -inch chains), 1 24-inch elbow, 1 scythe, 1 snath, 7 chairs, 1 office table, 2 engine lathes, 1 speed lathe, 1 upright drill, 31 turning tools, 1 12-inch chuck, 1 6-inch chuck, 1 No. 3 drill chuck, 16 twist drills, 1 No. 2 drill chuck, 3 reamers for Desper meter, 4 small reamers, 5 lanterns.

EXTRAS—2 bench vises, 1 steel wrench, 1 meter chuck, 1 black walnut cabinet, 1 small slide-valve engine, 2 extra twist drills, 12 lathe dogs, 10 hack saws, 1 blow pipe, 1 hay scale, 1 furnace pot, 2 trowels, 1 tar kettle, 100 feet sheathing, 2 wood wheelbarrows, 2 pipe-cutters, 9 pair 10 x 4-inch rubber washers, 1 set  $\frac{1}{8}$  to 1-inch reamers, 1 1 x 4-inch tap, 1  $\frac{1}{2}$ -inch tap, 2  $\frac{3}{8}$ -inch taps, 2 cut-nippers, 1 hand vise, 1 set figures.

### **Property in Water Board and Superintendent's Office.**

17 chairs, 5 high chairs and high stools, 1 letter press, 7 desks with drawers, 3 standing desks, 3 office tables, 2 book-cases, 1 bill cabinet, 20 ink-stands, 1 clock, 1 glass mug, 3 waste baskets, 7 spittoons, 4 wrenches, 1 pick, 1 map of distributing main pipes, 1 large rubber mat, 2 grass mats, 2 water gauges, 1 screw driver, 1 safe, 1 key rack, 1 atlas of Lowell, 1 map of Lowell, 1 instrument for testing capacity of engines, 1 apparatus for making gate boxes, 1 hat rack, 1 umbrella rack, 1 water cooler, 1 feather duster, 1 black-walnut cabinet.

# ENGINEER'S REPORT.





# REPORT OF THE ENGINEER.

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OFFICE OF CITY ENGINEER,  
LOWELL, MASS., Jan. 1, 1889.

*To the Lowell Water Board:*

GENTLEMEN, — The undersigned submits the Sixteenth Annual Report of the work done by the pumping engines, and also the records as taken at the Beacon-street Reservoir. The calculations of the duty of the engines were made from the records kept by the late Mr. Lewis Stiles from Jan. 1 to April 5, 1888, and Mr. James P. Roberts from April 5 to Jan. 1, 1889.

All the coal used at the station for pumping, heating, and power for the machine room has been charged to pumping; no deduction has been made, and in the calculation of the duty nothing has been added for friction in the pump.

During the year the Morris engine has run two hundred and seventeen, and the Worthington engine one hundred and nineteen nights. The largest quantity pumped during one day by both engines was 9,429,140 gallons.

The cost of pumping one million gallons from the low-service reservoir to the high-service reservoir is \$8.68, which, added to the average cost of raising the same quantity into the Beacon-street Reservoir, makes the total cost of pumping one million gallons into the high-service reservoir \$15.60.

**Table Showing Work Done with Morris Engine (Beam and Fly Wheel) and Boilers for each Month  
During the Year 1888.**

MONTHS.	No. of days' pump-pumping log.	Av. No. of hours' pump-pumping per day.	Number of hours' pumping month.	Number of strokes made per month.	Average No. of strokes made per minute.	Average head, including friction, in feet.	Quantity pumped per month, in U. S. gallons.	Average quantity pumped per U. S. galls.	No. gals. raised in boiler per lb. total coal consumed.	Duty in lbs., 1 foot high, with 100 lbs. coal, used in pumping only, no deduction for ashes or clinkers.	Duty on total coal consumed, no deduction for ashes or clinkers.
January.....	27	H M 20-39	557-45	407,209	12.17	164.30	130,306,880	4,826,181	562	92,353,064	76,907,804
February .....	26	22-40	589-30	430,160	12.16	165.06	137,651,200	5,294,277	552	90,383,038	75,954,403
March .....	27	22-22	631-00	482,732	12.75	164.08	154,474,240	5,721,268	563	91,285,500	76,924,500
April .....	22	19-46	434-55	329,963	12.64	163.55	105,588,160	4,799,462	578	95,266,674	78,786,527
May .....	17	20-11	343-05	252,029	12.24	163.63	80,649,280	4,744,075	573	95,835,500	78,133,554
June .....	25	20-34	514-10	366,198	11.87	164.26	117,183,360	4,687,334	600	99,948,500	82,138,943
July .....	30	21-28	644-00	468,309	12.12	164.44	149,858,880	4,995,296	597	99,166,114	81,756,792
August .....	31	20-32	636-30	451,650	11.83	163.95	144,528,000	4,662,193	613	103,013,658	83,783,269
September .....	21	20-20	427-10	299,280	11.67	164.47	95,769,600	4,560,457	602	101,320,420	82,477,912
October .....	12	20-08	241-35	171,138	11.81	163.93	54,764,160	4,563,680	595	99,757,860	81,324,352
November.....	..	.....	.....	.....	.....	.....	.....	.....	...	.....	.....
December .....	12	22-25	281-00	204,255	12.11	164.46	65,361,600	5,446,800	567	93,220,851	77,764,964
Totals and averages ..	250	21-12	5,300-40	3,802,923	12.15	164.22	1,236,135,360	4,944,541	581	96,130,259	79,505,345

**Table Showing Work Done with Worthington Duplex Engine for each Month During the Year 1888.**

MONTHS.	No. of days' pump- ing.	Av. No. of hours' pumping per day.		Number of hours' pumping per month.	Number of strokes made per month.	Average No. of strokes including made per minute.		Quantity pumped per month, in U. S. gallons.	Average quantity pumped per day, in U. S. galls.	No. gals. of water raised in- to reser- voir per lb. total coal con- sumed.	Duty in lbs., 1 foot high, with 100 lbs. coal used in pumping on- ly, no deduc- tion for ash- es or clinkers.	Duty on to- tal coal con- sumed, no deduction for ashes or clinkers.
		H	M									
January.....	20	20-22	407-30		244,442	10.00	165.20	75,777,020	3,788,851	410	66,493,333	56,494,026
February.....	17	17-56	305-00		167,155	9.13	167.06	51,818,050	3,048,121	388	63,958,441	54,000,838
March .....	4	24-00	96-00		49,476	8.59	167.03	15,337,560	3,834,390	390	64,894,567	54,328,488
April .....	3	22-20	67-00		49,238	12.25	163.08	15,263,780	5,087,927	394	61,159,014	53,577,321
May .....	11	21-49	240-00		172,814	12.00	163.36	53,573,340	4,870,213	420	65,354,515	57,159,592
June .....	6	21-15	127-30		96,798	12.65	163.95	30,007,380	5,001,230	419	65,184,209	57,183,908
July .....	..	.....	.....		.....	.....	.....	.....	.....	...	.....	.....
August .....	..	.....	.....		.....	.....	.....	.....	.....	...	.....	.....
September .....	7	19-51	139-00		102,130	12.25	164.49	31,660,300	4,522,900	447	71,150,541	61,215,557
October.....	20	19-44	394-35		273,513	11.55	162.69	84,789,030	4,239,451	432	68,389,016	58,594,267
November.....	28	21-48	610-15		431,947	11.80	162.84	133,903,570	4,782,270	422	65,960,697	57,307,382
December .....	19	22-01	418-15		302,510	12.05	163.30	93,778,100	4,935,689	423	66,196,379	57,593,227
Totals and averages..	135	20-47	2,805-05		1,890,023	11.23	164.07	585,907,130	4,340,052	418	66,296,955	57,188,553

**Table Showing Amount of Coal Used for Morris Engine  
at Pumping Station during the Year 1888.**

MONTHS.	COAL CONSUMED.			
	For starting fires, in lbs.	When pumping, in lbs.	For banking fires, in lbs.	Total per month, in lbs.
January.....	28,800	193,200	10,000	232,000
February.....	29,400	209,500	10,400	249,300
March .....	31,800	231,400	11,400	274,600
April .....	22,200	151,070	9,400	182,670
May .....	17,400	114,760	8,600	140,760
June .....	25,800	160,500	9,000	195,300
July .....	32,400	207,100	11,700	251,200
August .....	32,400	191,700	11,600	235,700
September ...	21,600	129,560	8,000	159,160
October .....	12,600	75,000	4,400	92,000
November....	.....	.....	.....	.....
December ....	14,100	96,100	5,000	115,200
Totals ...	268,500	1,759,890	99,500	2,127,890

**Table Showing Amount of Coal Used for Worthington Du-  
plex Engine at Pumping Station during the Year 1888.**

MONTHS.	COAL CONSUMED.			
	For starting fires, in lbs.	When pumping, in lbs.	For banking fires, in lbs.	Total per month, in lbs.
January.....	21,000	156,900	7,000	184,900
February ....	15,600	112,800	5,200	133,600
March .....	4,800	32,900	1,600	39,300
April .....	3,600	33,920	1,200	38,720
May .....	12,000	111,600	4,000	127,600
June .....	6,600	62,900	2,200	71,700
July .....	.....	.....	.....	.....
August .....	.....	.....	.....	.....
September ...	7,500	61,000	2,400	70,900
October .....	20,700	168,100	7,400	196,200
November....	30,600	275,500	11,000	317,100
December ....	21,600	192,800	7,200	221,600
Totals ...	144,000	1,208,420	49,200	1,401,620

**Table showing Work done with Worthington High-Service Engine for each Month during the Year 1888.**

MONTHS.	No. of days' pumping.	No. of hours pumping per day.	H. M.	Av. No. of hours' pumping per month.	H. M.	No. of strokes made per month.	Av. No. of strokes made per minute.	Av. head, including friction, in feet.	Quantity pumped per month, in U. S. gallons.	Av. quantity pumped per day, in U. S. gallons.	No. gals. water pumped into reservoir per lb. of total coal consumed.	Coal, in lbs., used when pumping.
January.....	6	14-40	88-00			187,920	35.59	78.67	2,030,880	498,480	309	8,500
February.....	4	13-15	53-00			117,259	36.87	78.67	1,641,626	410,406	322	5,100
March .....	5	12-00	60-00			139,524	38.75	78.67	1,953,336	390,667	315	6,200
April .....	4	11-19	45-15			97,146	35.78	78.67	1,360,044	340,011	318	4,280
May .....	5	12-00	60-00			127,690	35.47	78.44	1,787,660	357,532	323	5,540
June .....	4	17-37	70-30			140,959	33.32	78.67	1,973,426	493,356	346	5,700
July .....	5	16-48	84-00			173,132	34.35	78.67	2,423,848	484,770	326	7,440
August .....	5	18-34	92-50			202,143	36.29	78.67	2,830,002	566,000	363	7,800
September .....	4	14-45	59-00			120,439	34.02	78.09	1,986,146	421,536	351	4,800
October .....	4	14-52	59-30			106,735	29.89	78.67	1,494,290	373,572	332	4,500
November.....	5	13-54	69-30			140,608	33.72	78.67	1,968,512	393,702	325	6,050
December .....	5	13-12	66-00			122,764	31.00	78.80	1,718,696	343,739	321	5,350
Totals and averages..	56	14-25	807-35			1,676,319	34.60	78.62	23,468,466	419,080	329	71,280



Table showing the average monthly and daily consumption of water for the year 1888:

MONTHS.	Gallons per Month.	Gallons per Day.
January .....	204,958,671	6,611,570
February .....	194,530,130	6,707,935
March .....	164,468,200	5,305,426
April.....	126,399,525	4,213,317
May.....	131,475,851	4,241,156
June .....	145,094,663	4,836,489
July.....	150,910,892	4,868,093
August .....	144,038,037	4,646,388
September .....	131,028,476	4,367,616
October .....	135,744,128	4,378,843
November .....	135,370,434	4,512,348
December .....	159,070,217	5,131,297
Total and average.....	1,823,089,224	4,981,118

#### WATER ANALYSES.

About the middle of each month during the year samples of water have been taken from the following places: Center of Merrimack River, opposite the filtering basin; filtering gallery chamber; Bodwell gate-house; at the end of the brick conduit, and the Beacon-street Reservoir gate-house from the distribution chamber. These samples have been sent to the State Board of Health, and the result of the analyses will be given in their annual report.

Respectfully submitted,

GEORGE E. EVANS,

*City Engineer.*

REPORT  
OF THE  
LOWELL WATER BOARD  
As to Results Following Investigations of  
MECHANICAL FILTERS.





the  
of

1884

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TILDEN FOUNDATION.

# MECHANICAL FILTRATION.

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CITY OF LOWELL,  
IN WATER BOARD, Nov. 15, 1888.

On motion of Mr. Shaw :

THAT WHEREAS, The Lowell Water Board, as a result of investigation upon the subject of filtration, as applied to the treatment of water for the supplies of cities and for domestic uses, is possessed of information of sufficient value to warrant preservation for use of succeeding administrations, it was

*Voted*, That the clerk of the Water Board, under the direction of the president, at once prepare a report, detailing facts and results reached during such investigation.

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## REPORT.

During the spring of the present year, a subject of vital moment to the people of the City of Lowell was brought to the attention of the Lowell Water Board, namely : the condition of Merrimack River water, relative to its fitness for domestic use as supplied the residents of Lowell, under the administration of the Lowell Water Works department. The subject resolves itself into two heads or queries, viz. :

1. What is the condition of the water as furnished to-day, and is there any evident deterioration in purity as shown by comparison with the records of preceding years ?
2. Can our water be improved in quality, either by natural or mechanical process ?

It will be noted that no attempt is made by this report to allay any uneasiness in the public mind concerning the condition of the river water. Facts are dealt with, and conclusions must be drawn therefrom. It should be known that each

month, under the supervision of the State Board of Health, samples of Lowell city water are analyzed, and returns of same made to City Hall. In addition to these routine reports, the Water Board, during the month of July, obtained samples for special analysis, with the following result, the number of parts given being parts in 100,000.

Number.	APPEARANCE.		ODOR.		RESIDUE ON EVAPORATION.				AMMONIA.		Chlorine.	Nitrates.	Nitrites.	Hardness.
	Turbidity.	Color.	Cold.	Hot.	Total.	Loss on Ignition.	Fixed.	Odor on Ignition.	Free.	Albuminoid.				
1.	Clear, no sediment.	0.1	None.	None.	3.60	1.00	2.60	Faintly Peaty.	.0032	.007	.18	.02	.00	1.27
2.	Slightly flocculent sediment.	0.1	None.	None.	4.05	1.20	2.85	Faintly Peaty.	.0014	.011	.20	.022	.00	1.27
3.	Very slight sediment.	0.	Faint Musty.	Faint Musty.	2.90	.95	1.95	Faintly Peaty.	.0000	.009	.10	.012	.00	1.11
*4.	Flocculent sediment.	0.15	Faint Mouldy.	Faint Straw-like.	6.20	1.55	4.65	Peaty.	.0042	.022	.28	.007	.0004	1.56

\* Contains rotifers.

No. 1 is water from filter gallery.

No. 2 is water from city tap.

No. 3 is water from Lake Winnipiseogee.

No. 4 is water from Central Bridge.

The above is an accurate analysis made by Prof. Lewis M. Norton, who, at the time, sent the Board the accompanying letter:

MASSACHUSETTS INSTITUTE OF TECHNOLOGY,  
BOSTON, Aug. 4, 1888.

*Lowell Water Board:*

GENTLEMEN,— I enclose the figures furnished by the analysis of the four samples of water received from you. Nos. 1, 2, and 3 are excellent waters for domestic use. They contain no evidence whatever of any harmful contamination. They are superior to very many of the waters used in this commonwealth for domestic purposes. No. 4 is less desirable for the above mentioned purpose. If filtered, the analysis does not indicate that it would be objectionable for domestic supply. It is much inferior to Nos. 1, 2, and 3.

Yours very truly,

LEWIS M. NORTON.

So much for City of Lowell water during the spring and summer of 1888. Mr. Evans, City Engineer, states that during this period the city water was never so good before, a remark quite generally made by others, perhaps not so well qualified to judge. But it will be said, and truthfully, that the condition of

the river water varies from time to time, as is shown by what has occurred during the fall months of the year. A rain-fall period of unusual length occurred, and the result was at once noticed in the changed appearance of the water, though no harmful traces were apparent. Thus, admitting much of the credit of the water's condition due to nature's assistance, still in no small degree was the renewed use of the filter basin an important aid, permitting some days of almost the entire consumption being drawn from the filter gallery. The rains, however, rendered the condition of the river water so muddy that the filter basin was rendered useless, as it must be until the river becomes clear again, when, after cleansing, it can again be used with success. From the results attained, however, it is established that while the river is free from silt, splendid water can be furnished consumers, the supply being limited only by the capacity of the basin. This result, of itself, is sufficient reason why this valuable, though limited, adjunct to a pure water supply for the City of Lowell should not again be permitted to run to ruin, neglected, and unused. The expense of cleansing monthly, fortnightly, or weekly, is trifling and pays well for the outlay. But from what is thus far written, it is evident that at the critical period when danger lies in the water, if such condition does exist at any time of the year, when the water runs with silt or is sealed by the ice of winter, the basin is of no use. Then of all times it is needed. Thus it will be understood why natural means of filtration under local conditions in our climate must fail to solve the problem, How shall Lowell secure pure water?

These facts confronting the Water Board of 1888, attention was turned to the mechanical filters which have come quite generally into use for mechanical purposes, and to some extent for the filtration of water for the supply of cities of this country and to a very large extent in Europe, where many of the important cities have filtration works of great magnitude and cost.

Before proceeding farther it will be asked, What is a mechanical filter? The filtering process is common in nature. To it is due the clearness of sparkling spring water. This natural system when applicable, on the score of economy, possibly is to

be preferred; but in the majority of cases, where filtration galleries have been constructed, they have proved unsatisfactory. Of artificially prepared filter beds, approaching the process of nature, our own above Pawtucket Falls is an example, and its attendant difficulties have been mentioned. The mechanical filter undertakes to overcome the objections to the filter-bed system. Speaking in a general way, it consists of a tank containing a bed of coarse sand, or gravel, through which the water to be filtered is passed, generally under pressure, the mechanical construction providing means for the feeding of chemicals, to act as a coagulant, and also a system of valves permitting frequent, or as often as needed, washing of the sand.

Members of the Lowell Water Board, with the City Engineer, have seen a practical working of the following mechanical filters: the Hyatt, owned by the Hyatt Pure Water Company, of New York, J. M. Hyatt president and inventor; the Jewell, owned by the Jewell Pure Water Company, of Chicago, and represented by Morrison, Allen & Co., of New York City; the National, owned by the National Purifying Company, of New York City; the Warren, owned by the Cumberland Manufacturing Company, of Boston; the Oliphant, owned by the Hege-man & Oliphant Filter Company, of New York City; and the Moore.

The work of the Hyatt filter was seen at Somerville, N. J., the first city plant erected in this country, as claimed by the company. The water works at that city supply Somerville and the town of Raritan, N. J. The filter plant has a claimed capacity of 500,000 gallons per day. The Raritan River, the source of supply, at times becomes very muddy, wholly unfit for domestic use. The exhibition of the working of the filter was satisfactory in every particular, and its results were highly praised by resident consumers conversed with. At Long Branch, N. J., the Board had opportunity of seeing one of the newest Hyatt systems, such as the Hyatt people recommend for Lowell. The plant consists of eight 10-foot diameter filters, with a capacity of from two to three million gallons per day. The supply at Long Branch is from an artificial pond, fed by water-ways coming through swamp land. During rainy seasons



the water becomes very much colored, its "Jersey Lightning" hue being attributed to the character of the source—a cedar swamp. Here, too, the testimony of citizens was favorable to the Hyatt filter. In fact it could not be otherwise, as previous to the introduction of the filters the water could not be used, being, as stated, wholly unfit to drink. Samples of this water (at the time at its maximum purity) before and after filtration were taken, sealed, and expressed to Boston, where they were analyzed, with the following result—the number of parts given being parts of 100,000 :

APPEARANCE.		ODOR.		RESIDUE ON EVAPORATION.				AMMONIA					
Turbidity.	Color.	Cold.	Hot.	Total.	Loss on ignition.	Fixed.	Odor on ignition.	Free.	Albuminoid.	Nitrates.	Nitrites.	Hardness.	Chlorine.
* Brown sediment. Distinct.	0.15	Faintly Mouldy.	Faintly Mouldy.	9.40	1.50	7.90	Peaty.	.014	.0176	.018	.0004	3.38	.86
† None.	None.	None.	None.	9.00	1.50	7.50	Faintly Peaty.	.0014	.0060	.007	None	3.38	.90

\* Before.

† After.

The above analysis from Professor Norton, it is presumed, is a fair exhibit of what a Hyatt filter will do at the season of the year when the test was made. It is unnecessary to state that in this and other cases the chemist has no knowledge of where water is from, or conditions of taking. Both Somerville and Long Branch plants are located at the pumping station, and require no extra help for their care. At Newark, N. J., at the machine shops of the Newark Filtering Company, an opportunity was offered to examine the parts of the Hyatt filter in detail. This was done with the view of forming some idea as to the probable effect of Merrimack River water upon the iron interior parts, a matter worthy of consideration, following the experience of Lowell with its iron street service pipes. In short, would not the action of Merrimack River water upon the interior in a few years render the entire inner working impracticable? Past experience with iron would indicate such a result



as probable. This, however, in itself, would not stand as an argument against the introduction of a mechanical filter, as the parts could in time be renewed, if the results obtained, even for a limited period, were satisfactory to consumers. The endorsements shown by the Hyatt people are very strong, and they have a decided advantage as exhibitors, in being able to show complete systems at work, and at convenient points for visit.

In 1886, under date of Feb. 8th, the following order passed the United States Senate:

*Resolved*, That the Secretary of War be, and he is hereby, requested to ascertain the advisability and practicability of providing the water supply of the capital with filters and other appliances for cleansing and purifying the water, and to report the result of his inquiries, together with plans and estimates of the cost and application of the same.

A copy of the letter from S. V. Genet, at the time Acting Secretary of War, and dated May 25, 1886, together with reports made by the United States Government engineers, in compliance with the above resolution, are in the hands of the Lowell Water Board. Copied from the report, the situation at the National Capital regarding its Potomac River supply is this: "In quality the water of the Potomac is perhaps as good as that of any river of its size flowing to the Atlantic sea-board. As a source of water supply for a large city, the Potomac has the inherent defects which accompany most river sources, and these defects become more and more marked with the advance of civilization. It flows through rich valleys occupied by great numbers of people, with their flocks and herds. The lands are highly cultivated and have been for many years, and the use of fertilizers does and must increase with time. The cutting away of forests and clearing up of the mountain slopes brings about climatic changes, increasing the violence of storms and freshets. All injurious organic matter scattered about the land, in the shape of fertilizers and decaying vegetable and animal matter, is much more readily washed into the running streams and finds its way to the source of our water supply. The floods also gather larger amounts than formerly of the organic matter of the soils through which the waters flow. The increasing size and number of the towns, the sewage from which mostly finds

its way in some form or other to the Potomac, are elements to be considered in discovering the defects of our water supply and their remedy. During the summer months, when the rains are few, light, and of short duration, the Potomac is a comparatively clear stream, and the water supplied to the city is of very excellent appearance. But in the autumn, winter, and spring, the period of the year when storms and freshets most prevail, the water becomes more or less impregnated with impurities of all kinds, and the supply as it reaches the city is repulsive in appearance, fills the mind with misgivings as to its wholesomeness, is a drawback on the growth and development of the city, is deleterious to health and morals, and is a source of expense and worry to all householders who are obliged to keep filters for its purification."

The report further says that on investigation the practicability of filtering the water supply of Washington, the inadaptability of the natural infiltration system was soon apparent, and the many disadvantages of the filter bed system were recognized. Filters in which certain chemical and mechanical features are involved have been in use for household, laboratory, and manufacturing purposes for many years, and examination into every form and description of apparatus was made, to see if any were applicable on the larger scale required for a city plant. The result was the conviction that the practical solution of the problem lay in this direction. Following this statement, the Hyatt system is named as the then (1886), in the opinion of the engineers, most desirable plan of filtration. In the report a plan is submitted, the essential features of which are the same as the Lowell party witnessed in actual working at Somerville, N. J., the difference being in the size and capacity of the tanks. The report closes by recommending the appropriation of \$600,000, or as much thereof as needed, to carry out plans submitted. The foregoing must be taken as the endorsement of the United States Government, at that time.

Notwithstanding the favorable and pronounced character of this report, it would appear that no action toward the improvement of Potomac River water has yet been taken by those who have the direction of affairs at Washington. A letter of inquiry

sent to the War Department office, asking what the results of the Government investigation were likely to be, and why matters were delayed, brought the following reply :

DISTRICT OF COLUMBIA,  
Water Supply, Sewerage, Street Lighting, etc.,  
WASHINGTON, Nov. 24, 1888.

*To the Lowell Water Board, Lowell, Mass. :*

GENTLEMEN, — In answer to your letter of Nov. 15, 1888, I have the honor to inform you that we have never made any experiments with any mechanical filter, other than observing their operations and getting data and information from those who had used them.

We are not, at present, considering taking such a step. It was expected to make exhaustive experiments and inviting competition, if congress had appropriated money for the work of putting in a filter plant in this city; but congress having made no appropriation for this method of improving our water, nothing further was done.

The only reason that I know for dropping the subject of filtration is the apathy with which the subject was regarded by a great many, and the antipathy on the part of others to spend money for an improvement of this character.

The filters which to me seemed far the best, at the time of my examination into the subject and report, were those manufactured in Newark by the Hyatt Filtering Company.

Very respectfully,

THOS. W. SYMONS,

*Captain of Engineers, U. S. A.*

Since then, other filters have come upon the market, and improvements are claimed. It would be strange if such were not the case, and the Hyatt people are among those who claim to show improvements. Mention of the Hyatt will properly be followed by notice of the Jewell and National systems. To an ordinary observer the three have much in common. There are differences in manner of construction, but the same general results are obtained, and in much the same way. The chemical used in the treatment of water by these three filters as a coagulant is generally alum. As to its effects upon water thus treated, more will be said.

The Water Board witnessed the working of an experimental Jewell plant which has been in operation at Brockton, Mass., for several months. The water treated was pumped direct from the Brockton reservoir. The water in appearance was bad. Its odor was worse. Undoubtedly Brockton water was seen at its worst, at the time of the Lowell party's visit. Feelings of solicitude were somewhat mitigated by assurances that "the

water was not as bad as it looked." Bad as it was, the Jewell filter, with the aid of alum as a coagulant, effected a complete transformation, producing water clear as crystal, although the disagreeable odor remained.

It may be said here that at the request of the Brockton authorities, the Massachusetts State Board of Health have, during the summer, given special attention to the matter of mechanical filtration, and especially to the work accomplished by the Jewell system at Brockton, as well as by one of the Hyatt plants at Holyoke. The Lowell Water Board, determined to avail themselves of all information obtainable, have waited for the report of this acknowledged high and valuable authority. The State Board have also recently made this report, and its special value will be found in what is said regarding the action of chemicals and the traces that are found to remain that would in any way affect the desirability of the water's use. In response to a letter, the following is a reply :

COMMONWEALTH OF MASSACHUSETTS,  
STATE BOARD OF HEALTH,  
13 Beacon Street, Boston, Oct. 15, 1888.

DEAR SIR,— In reply to your letter of inquiry as to the examination of certain filters named in your letter, I would respectfully reply that the examinations thus far conducted have not reached such a stage as to warrant any definite conclusions upon the subject.

Respectfully yours, SAMUEL W. ABBOTT,  
*Secretary State Board of Health.*

Under date of Nov. 17th, a second request was made, and the following reply returned :

STATE BOARD OF HEALTH,  
Chief Engineer's Office, 13 Beacon Street,  
BOSTON, MASS., Nov. 20, 1888.

DEAR SIR,— I understand that the report of the state board of health to the city of Brockton has been published in full in the Brockton *Enterprise*. I am now writing for some copies of the paper, and will ask them to send one to you. The board investigated the subject with special reference to the purification of the Brockton water, and have not considered at all the relative merits of different filters.

Very truly yours, F. P. STEARNS,  
*Chief Engineer.*

The Brockton *Enterprise*, of Nov. 10th, contains the State Board of Health report. The portions of interest only to the City of Brockton are omitted in what follows :



OFFICE STATE BOARD OF HEALTH,  
BOSTON, Nov. 7, 1888.

*To the Water Commissioners of Brockton:*

GENTLEMEN,—In response to the request of the Water Commissioners of Brockton, of March 29, 1888, that the State Board of Health would advise them as to what method they should adopt to effect a permanent improvement in the water of their city, which was unfit for domestic use in August and September of last year, the State Board of Health has had examinations made, which show that the probable cause of trouble was the growth and decay of vegetable and animal matter, which growth is favored by the large area of meadows and swamp lands, which drain into the reservoir the water which they receive from the adjacent uplands. Two possible methods of relief are presented: *first*, to prevent the growth of objectionable substances; *second*, to remove them and their effects after they have grown. . . . Of the second method of relief,—that of removing objectionable organisms after the water has received them,—natural filtration through the banks of the reservoir, or of the stream, appears to be out of the question, on account of impervious nature of the ground. Experiments have been made by the Board at Brockton and elsewhere with various appliances for rapid artificial filtration through sand and without the help of alum. These filters have acted continuously, except while the filtering material was being washed. In all these experiments, when alum alone was used, the number of organisms was sometimes reduced to one-third and sometimes one-quarter; but with the deeply colored Brockton water of August and September, the filtered water had the same appearance as the water of the reservoir, and the chemical analysis showed a very imperfect removal of the green growth. Such filtration would not be at all satisfactory. When alum is used with the sand, the number of microscopic organisms is reduced to a greater or less degree, depending upon the amount of alum used. The ordinary amount claimed was one pound of alum for twenty-five thousand gallons of water. The experiments showed this amount had no effect upon the color, and reduced but little the number of bacteria. Neither was the color reduced by two pounds; but four pounds reduced the color and the number of bacteria a little more than one-half, and reduced the microscopic organisms to about ten per cent. Six pounds of alum for twenty-five thousand gallons of water reduced the color to one-eighth of its original depth, reduced the bacteria and the microscopic organisms to one per cent. of the original number; but there was added to the water a large amount of ammonia and about one part in one hundred thousand of combined sulphuric acid. The appearance and taste of this water was satisfactory, but the Board of Health can not advise the use of water which has passed through and dissolved this amount of alum. . . .

SAMUEL W. ABBOTT,

*Secretary State Board of Health.*

While upon the subject of chemical purification of water, the following is instructive and of value, as the same is of United States Government finding: "Within the past few years a very extensive use has been made of certain substances which are known to act upon the soluble impurities of water, rendering them insoluble and then capable of removal by precipitation or

filtration. The value of these substances is still further enhanced if, in addition to their chemical action, they act mechanically, by modifying, holding, and carrying down in the process of precipitation any suspended foreign matter, like clay. Many substances have been found useful in this way, principally among which may be mentioned caustic lime, iron in many of its forms, various salts of potassium, alum, carbon, borax, etc. The substance which is most useful in any particular case depends upon the nature of the impurities present, the use to be made of the water, and the magnitude and cost of the work to be done. If the water is to be used for domestic purposes, the substance used must be absolutely and unequivocally free from any deleterious action on the human system under any circumstances within the limits of possibility, and it must be used in such proportion that when its work is completed it will give to the clarified water no chemical reaction or physiological properties. Without entering into a discussion of the various substances, it may be said that, as coadjutants and aids to the purification of water by filtration, alum, lime, and iron seemed possessed of greater advantages than any other materials. It does not necessarily follow, however, that they must be used all the time; in fact, their use would be limited, in all probability [certainly in the case of Lowell water], to those periods of the year when the water is the muddiest. Many exhaustive experiments have been made with alum by eminent chemists, and it has been found that when present in almost infinitesimal quantities, it possesses a wonderful effect on water. In some waters, as actual experiments show, if used in proper proportions, and the water then perfectly filtered, the result will be brighter, clearer, and purer than could be obtained without its use; and furthermore, no trace of the alum can be traced in the filtered water, it having united chemically with the impurities, and being left behind in the interstices of the filtering material, to be removed afterward by the washing of the filter. The use of alum would be very inexpensive, costing in its pure state from one and one-half to two cents per pound. If a small amount of lime-water be added to a natural water containing carbonic acid (and nearly all natural waters do), the result is the

formation of an insoluble precipitate of carbonate of lime, which envelops the suspended particles of clayey or other mineral matters and any coagulated, gelatinous, or albuminous substances, rendering them more capable of removal by filtration."

In the Hyatt and Jewell filters, as well as others to be mentioned, the apparatus providing for feeding the alum, lime, or whatever the coagulant, is capable of the most perfect regulation, so that the amount of coagulant used can be exactly proportioned to produce the desired effect, and can never be in excess. It will be understood, also, that the feeding apparatus is entirely independent of the filter itself, and can be used or unused at pleasure.

The National filter, which this report groups with the two previously mentioned, was seen at work at Holyoke. A new principle is claimed for it, namely, surface washing: a system whereby the top surface of the filter bed is washed, thereby making a claimed saving of about one-tenth of the amount of water in washing that is used by competing filters. The National people have a 3,000,000-gallon filter plant at Chattanooga, Tenn., and other smaller city plants at the West.

Before speaking of other filters, it should be said that the Hyatt people claim that both Jewell and National are infringers of their patents. As regards this, however, it is sufficient to say that the accused parties in each case profess willingness to stand suit,—in fact, the Hyatt and Jewell case is already in process of law,—and moreover, both are willing to furnish acceptable bonds, insuring any buyer or user of their filters protection against infringement claims of any and all concerns.

The Moore filter is to be seen at Lawrence, at the Russell paper mills. It was seen by the Lowell Board at Holyoke in a paper mill in that city. The claims of its inventor embrace all that is claimed for the filters spoken of, so far as good results go; and further, that his is the only automatically working washer,—that is, while in other machines an attendant must reverse the valves to effect the washing operation, in the Moore, at the necessary moment, the same result is accomplished automatically,—a clever conception to witness work, but requiring

much more water for the operation than by other methods witnessed.

The Warren filter was seen at the Cumberland paper mills, near Portland, Me. Here is to be seen a plant filtering 12,000,000 gallons daily for paper manufacturing uses. To use the words of the Warren people: "The merit of our filter lies first in the thorough system of cleansing, and secondly in the simplicity of construction." The first claim, that of cleansing, is accomplished by the scouring caused by a mechanical rotary rake, and the rinsing by a reversed flow of filtered water. At the time of visit at Portland the fall rains had set in, and the condition of the Presumpscot River was very muddy. Three samples of water were secured and sent to Professor Norton, of Boston, and the result follows, the parts being parts in 100,000:

APPEARANCE.		ODOR.		RESIDUE ON EVAPORATION.				AMMONIA					
Turbidity.	Color.	Cold.	Hot.	Total.	Loss on ignition.	Fixed.	Odor on ignition.	Free.	Albuminoids.	Chlorine.	Nitrates.	Nitrites.	Hardness.
*Small sediment.	.0	Faintly Musty.	Faintly Mouldy.	4.40	1.10	3.30	Peaty.	.105	.0174	.15	.007	0.	1.63
†Turbid. Small sediment.	.5	None.	Faintly Mouldy.	5.20	1.70	3.50	Peaty.	.002	.0204	.20	.007	0.	1.43
‡Small sediment.	.5	None.	Faintly Mouldy.	5.65	1.70	3.95	Peaty.	.002	.0204	.20	.007	0.	1.43

\* Filtered with alum.

† Filtered without alum.

‡ Unfiltered water.

It will be understood that the Warren filter at the Cumberland mills, the largest paper plant in the world, is called upon to furnish an enormous quantity of water,—more than double the present daily consumption in Lowell. Viewing this plant, it would seem to verify the fact that what is gained in rapidity of filtration pure and simple is lost in efficiency.

The last filter this report will speak of is that called the Oliphant, after its inventor, William Oliphant. As to its appearance, while the majority of those spoken of resemble an upright boiler, so far as concerns their shells, the Oliphant resembles a horizontal boiler. While in the other filters par-



tially described the water undergoing filtration pours downward, the course in the Oliphant is upward. The work of the Oliphant was seen at Seneca Falls, N. Y., at the Gleason Company's mills, where the filtered water is used for boiler and washing purposes with good results. The distinct feature which attracted the attention of the Lowell Board to the claim of the Oliphant was the strong claims made as to what this filter would accomplish without the use of any chemical whatever, except when water was at its very worst state of foulness, and then the strong advocacy of the use of lime, rather than alum, as a coagulant. Considerable color is given to Oliphant's claims by his recent decided victory over competing filters in obtaining the contracts for furnishing filters for the new sugar-refining plant of Claus Spreckles, Philadelphia. This, as a fact, has been disputed by rival filters; but letters in possession of the Lowell Water Department from Mr. Spreckles' engineers, to whom the Lowell Water Board are under special obligation for valuable information, settles that point. The Spreckles people received some six estimates for these filter plants. It may be said authoritatively that the Oliphant plant will be put in simply on its merits, and that no other filter is going to be put in. This statement may be of value to other water departments of the country. The Spreckles engineers made their deciding test on the same plant visited by the Lowell people at Seneca Falls. The test was this: the filter was run for about half a day without blowing out the accumulated dirt in the lower chamber (the mechanical construction of the filter being understood), until the mixture of dirt and water in that chamber became so nontransparent that newspaper print could not be read through a tumblerful of it. From this dirt the filter continued to deliver clear water under different pressures, which were maintained for periods of thirty to forty minutes each; lowest pressure about eight pounds, and highest pressure fifty pounds. The capacity of the filter was then tried for removing clay, by mixing a fine, white fire-clay with the water. This test—a severe one—is thus described by the person making the test: "I did not at the time consider this a fair test, as the filter was then hardly arranged for this purpose, being filled with rather coarse filter-

ing material. Notwithstanding, the filter did a great deal better than I expected it would do, leaving only a very faint tinge in the water." Following this test, the Oliphant people received an order for a 5,000,000-gallon plant for the new Spreckles refinery. At Seneca Falls, City Engineer Evans took the following four samples of water, brought them to Lowell, where they were analyzed by Mr. William P. Atwood, of the Hamilton Manufacturing Company, Lowell. It will be understood that the work of filtering was by the Oliphant filter, and that no chemical was used:

Analysis four samples of water received Nov. 12, 1888. Results in parts per 100,000:

Number.	APPEARANCE.		ODOR.		RESIDUE ON EVAPORATION.				AMMONIA		Chlorine.	Nitrates and Nitrites.	Hardness.
	Turbidity.	Color.	Cold.	Hot.	Total.	Loss on Ignition.	Fixed.	Odor on Ignition.	Free.	Albuminoid.			
1.	Clear, slight brown sediment.	0	Very faint.	Same.	21.50	1.70	19.80	Very faintly Peaty.	.0040	.0104	3.61	.021	12.50
2.	Same.	0	"	"	21.00	1.80	19.20	"	.0056	.0092	3.61	.025	12.40
3.	*Very turbid. Heavy, silt-like sediment	Gray	"	"	174.50	20.70	153.80	Peaty.	.0016	.0280	....	.018	12.
3.	†Clear.	0	"	"	18.50	4.00	14.50	same as No. 1.	.0018	.0108	3.61	....	.....
4.	Same as No. 1.	0	"	"	21.40	4.20	17.20	"	.0160	.0204	3.72	.019	12.40

\*Unfiltered.

†Filtered.

Sample No. 1, unfiltered water.

Sample No. 2, filtered water.

Sample No. 3, unfiltered water, fire-clay added.

Sample No. 4, filtered water, fire-clay added.

Sample No. 1 has a very faint alkaline reaction.

Samples Nos. 2 and 4 are neutral.

Sample No. 3 has a plain alkaline reaction.

The hardness is expressed as parts per 100,000 of carbonate of lime.

WILLIAM P. ATWOOD.

The foregoing is the result of the Lowell Water Board's investigation of the question of desirability, practicability, and cost (the latter to be referred to later) of providing the water-supply of Lowell with mechanical filters for purifying the water. Certainly, if it is practicable, it is desirable; and if by any

means pure water can be supplied the inhabitants of Lowell during the twelve months of the year, no reasonable sum of money would seem too high a price to secure so great a boon. Various estimates for a filter plant of a capacity sufficient to filter 10,000,000 gallons of water daily are on file at the Lowell Water Works office. Such a plant would cost the city of Lowell not less than \$75,000. This is a large sum of money to stake upon an experiment, as an adoption of mechanical filtration must necessarily be, and continue to be for some time after its commencement of work. Nevertheless, from what has been witnessed and from knowledge gained, in the opinion of the Lowell Water Board,—a unanimous opinion,—an experiment is worth the trying. Lowell is peculiarly and favorably circumstanced to make such an experiment at a reasonable cost. It is probably well known that the present high-service system pumps its water independently of the Beacon-street reservoir supply. The high-service reservoir has a capacity for 1,500,000 gallons. As an experiment, it would be feasible to pass this supply through a filter before entering the reservoir,—this without extra expense other than the purchase of the filter. It could be accommodated in the basement of the pumping station, and would require no additional help for attendance. Such a filter could be set ready for work for less than \$1,500, and propositions for doing this by a number of filter concerns are on file at the Water Works office. This would certainly afford an excellent test of the merits of the systems, whichever one it might be decided to adopt. It has, however, been found an impossibility to gather evidence in full until the present late day,—too late for the present administration of the Water Department to take any decisive steps;—neither do they feel that it devolves upon them to recommend action to their successors in office. Valuable data for their assistance, should they view the matter in the same light as the government of 1888, will be at their disposal. Certainly no question of more vital importance, so far as concerns the welfare of the community, is likely to come before them for their consideration and disposal.

LOWELL WATER BOARD.

LOWELL, Nov. 28, 1888.





1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes the need for transparency and accountability in financial reporting.

2. The second part of the document outlines the various methods and techniques used to collect and analyze data. It includes a detailed description of the experimental procedures and the statistical analysis performed.

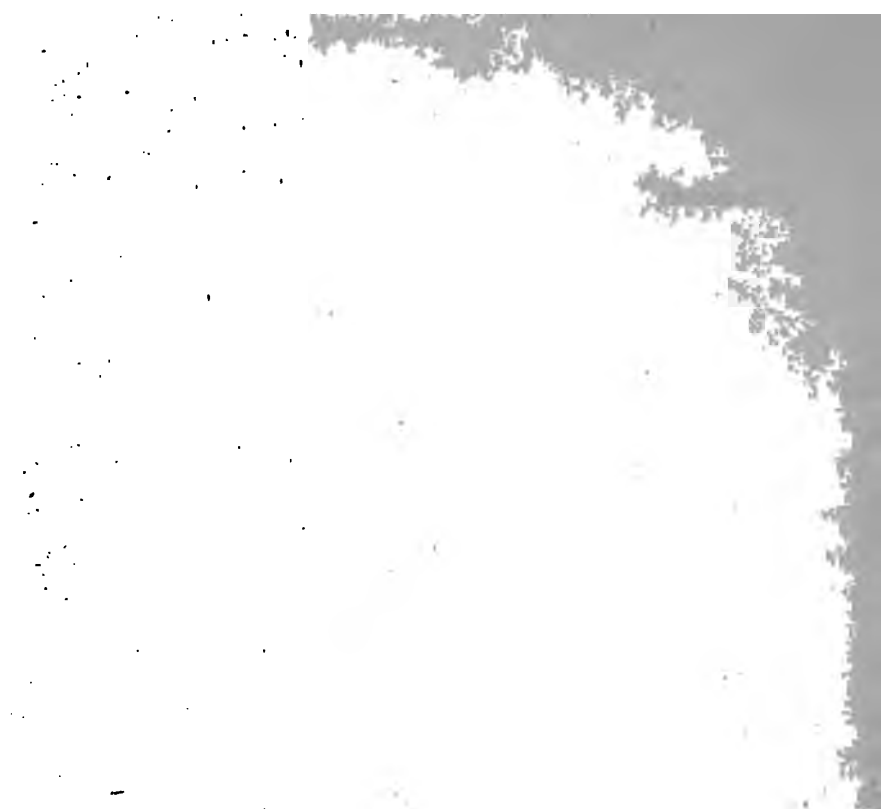
3. The third part of the document presents the results of the study. It includes a series of tables and graphs that illustrate the findings of the research. The data shows a clear trend of increasing activity over time.

4. The fourth part of the document discusses the implications of the findings. It suggests that the results have significant implications for the field of study and may lead to further research in this area.

5. The fifth part of the document concludes the study. It summarizes the key findings and provides a final statement on the importance of the research.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes the need for transparency and accountability in financial reporting.







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SEVENTEENTH

ANNUAL REPORT

OF THE

★  
LOWELL WATER BOARD

AND REPORTS OF

SUPERINTENDENT OF WATER WORKS  
AND CITY ENGINEER.

1889.



SEVENTEENTH  
ANNUAL REPORT  
OF THE  
LOWELL WATER BOARD,  
TO THE  
CITY COUNCIL OF THE CITY OF LOWELL, MASS.,  
AND THE  
REPORTS OF THE SUPERINTENDENT OF WATER WORKS AND  
OF THE CITY ENGINEER TO THE WATER  
BOARD, FOR 1889.



LOWELL, MASS.:  
VOX POPULI PRESS: 130 CENTRAL STREET.  
1890.

42847  
OR, LEND AND  
IN FOUNDATIONS  
1905

## CITY OF LOWELL.

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IN BOARD OF ALDERMEN, Jan. 14, 1890.

Received and ordered on file without reading.

Sent down for concurrence.

GIRARD P. DADMAN, *City Clerk.*

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IN COMMON COUNCIL, Jan. 14, 1890.

Received and ordered on file, in concurrence.

DAVID CHASE, *Clerk.*

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## WATER DEPARTMENT, 1889.

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### WATER BOARD.

ARNOLD S. WELCH, *Prest.*, term expires first Monday in May, 1890.  
GEORGE A. SCRIBNER, term expires first Monday in January, 1890.  
MILES F. BRENNAN, term expires second Monday in March, 1891.  
JOHN STOTT, term expires second Monday in March, 1892.  
ARTHUR F. SALMON, term expires second Monday in March, 1893.  
CHARLES L. KNAPP, *Secretary and Clerk.*

---

### MILLARD F. WRIGHT, *Superintendent.*

THOMAS F. DOYLE, *Foreman.*      ANTHONY F. COGER, *Services.*  
WILLIAM JOYCE, *Asst. Foreman.*      WALTER P. WILEY, *Meter Repairs.*

---

LEONARD T. FARRIS, *Service Clerk.*  
MARY G. SAWYER, *Book-keeper.*

---

JAMES P. ROBERTS, *Engineer.*      THOS. MCLOUGHLIN, *Asst. Engineer.*

---

### *Inspectors.*

JOHN J. BANCROFT,      THOMAS LENNON,  
WILLARD S. KNOWLTON,      ROBERT GARDNER, JR.,  
JULIAN L. WHITESIDE (resigned Nov. 1).

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GEORGE E. WORTHEN, *Leaks and Waste.*  
FRANK LAPOINT, *Reservoir.*



# REPORT OF THE WATER BOARD.

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OFFICE OF LOWELL WATER BOARD,  
LOWELL, Jan. 6, 1890.

*To the Honorable the City Council of the City of  
Lowell:*

The Lowell Water Board herewith submits to your honorable body its annual report for the year 1889.

The reports of the Superintendent of Water Works and of the City Engineer accompany this report, to which you are respectfully referred for the details of work of construction and that of pumping water, during the year. Appended also is a report made to the Lowell Water Board by City Physician J. Arthur Gage, A. M., M. D., relative to the present condition of Merrimack - river water, together with matter bearing upon the subject of Mechanical Filtration, as a means of improving the quality of water as supplied the inhabitants of Lowell by the Lowell Water Works.



## ORGANIZATION.

At the final meeting held by the City Council of the government of 1888, an ordinance, amending Chap. 39 of the Revised Ordinance, whereby the method of choosing members of the Water Board is changed, took its final passage and was signed by Mayor Palmer. The effect of the change is, in part, to make the composition of the Water Board as follows: There shall be five members, as formerly—one to be elected each year by concurrent vote of the City Council from the Board of Aldermen; four others shall be similarly chosen by the City Council, who shall be citizens holding no other municipal office, one being chosen each year for a term of four years. Thus shall the Water Board always retain at least three members who have had experience in the management of affairs of the Water Department. The amendment further provides that the Superintendent shall be chosen by the Water Board, and not, as formerly, by the City Council.

Under the provisions of the new ordinance, four members of the present Water Board were elected, as follows: Arthur F. Salmon for the term of four years, John Stott for the term of three years, and Miles F. Brennan for the term of two years, from the citizens, and George A. Scribner from the Board of Aldermen. Arnold S. Welch, member of the Water Board of 1888, and elected under the former

ordinance for two years, retained his seat as member of the 1889 Board.

The above, constituting the Water Board of 1889, held their first meeting on the evening of March 11, 1889, and organized by the choice of Arnold S. Welch as President of the Board.

Millard F. Wright was elected Superintendent of Water Works.

At a subsequent meeting, and in compliance with the ordinance, the Water Board re-elected, for its secretary and clerk, Charles L. Knapp.

#### THE PAST YEAR'S WORK IN GENERAL.

The work of the year has been completed without mishap, and the operations of all departments have been satisfactorily conducted. It will be seen that the amount of work performed on streets, embraced in extension of mains, new services, renewals of old services, and other work, has been unusually large. This, together with the abundant evidence on every hand of the continued steady growth of the business of the department, is indicated by the following concise summary of principal features, in form of results, with comparison:

	1889.	1888.
Actual charges for 12 months of year, including water, labor, and materials .....	\$191,594.87	\$185,012.92
Expenditures, as per City Auditor, including payments of interest..	193,535.48	183,279.73

Net cash receipts, as per City Treasurer .....	\$189,247.66	\$183,139.37
Length water mains laid.....	20,510 ft.	17,484 ft.
"      "      "      relaid.....	898 ft.	3,385 ft.
"      "      "      increase.. .	19,612 ft.	14,099 ft.
Number of new service connections	356	336
Number of service connections renewed.....	239	204
Number of hydrants set.....	21	24
Number of meters set at City's expense .....	14	..
Number of meters set at takers' expense .....	141	..
Total length of water mains to date	470,747 ft.	
Total number services.....	8,471	
Total number meters in use.....	1,757	1,630
Total number hydrants.....	844	
Salaries and pay rolls.....	\$33,554.68	\$32,124.25
Charges of year, including uncollected money of previous year, and not including charges of November and December.....	194,038.56	189,683.25
Of the immediately preceding item, amount uncollected or not shut off for non-payment (indicating condition of collections).....	182.14	
Total amount of water pumped (U. S. gallons).....	1,691,804,700	1,822,042,490
Daily average pumped (U. S. gallons) .....	4,654,259	4,978,258
Daily average consumption .....	4,633,165	
Total consumption of coal (City Engineer's figures, tons).....	1,560 <sup>1883</sup> <sub>3000</sub>	1,800 <sup>770</sup> <sub>3000</sub>

Cost of pumping 1,000,000 gallons:		
Morris engine.....	\$6.64	\$6.47
Worthington engine.....	8.40	7.86
Average price of coal:		
Morris engine.....	4.30	4.47
Worthington engine.....	4.35	4.42
Gross debt on account Water Works.....	\$1,828,000.00	
Sinking funds, Jan. 1, 1890.....	688,444.35	
<hr/>		
Bonded indebtedness (net) of City on account of Water Works, Dec. 31, 1889.....	\$1,144,555.65	
Total receipts, all sources, 1889 (including 1888 balance, \$5,244.23).....	194,491.89	
Total expenditures, including interest account...	193,535.48	
<hr/>		
Balance carried to 1890 account.....	\$ 956.41	
Total expenditures on Water Works to Jan. 1, 1890 .....	4,647,118.95	
Total receipts from Water Works to Jan. 1, 1890.....	2,259,434.67	
<hr/>		
Net cost of Water Works to Jan. 1, 1890..	\$2,387,684.28	

The calls for extensions of street mains have been numerous. It has been the policy of the Water Board to grant requests of this kind, whenever the income promised would seem to warrant the work, and in thus acting we have done so always with liberal views as to future possibilities. Such a policy we hold to be right. Every encouragement should be granted that will tend to push the speedy development of Lowell. We offer such encouragement, we believe, when we extend our pipes to and through



new sections that are building, even though substantial return is delayed a few years. Following such a policy, our expenditures for street-main extensions alone have been unusually large.

You will note that we have added 356 consumers, as indicated by the number of new services laid during the year—a large number, and a positive indication of the advancement of property interests in the city. The charge for water, showing as it does an increase over the charges for water in 1888, of \$3,715.09, is undoubtedly less than would have been but for the very wet season of summer weather, preceded by an unusually mild winter. Continuous cold weather in winter and a dry season during summer months are the causes of heavy draughts of water; the opposite extremes of conditions have existed throughout the year. The volume of a year's business to-day is practically \$200,000. Conditions as above mentioned may another year cause these figures to be exceeded, or for reverse causes they may be less. But it may be said that the department's business has reached the magnitude indicated by these figures. Having reached that high mark, and with the Lowell Water Works' plant in the splendid condition that it is, certainly is a matter of congratulation for you, and for those you have been chosen to represent. We have said that no serious mishap has occurred during the year. It may be remarked in this connection that the history of the

Lowell Water Works shows that, in this regard, with the exception of the reservoir accident during 1885, the department has been remarkably fortunate. It can not in justice be attributed to "fortune," however; for while we know not how soon accident may befall us, the fact that it has been delayed thus far redounds to the lasting credit of those men who have preceded us, and whose thorough methods have given us our splendid system, proof as it has been against accidents. The rapid development and increased demands of subsequent years, show errors in judgment, particularly in the small size of street mains in some localities; but in the main, evidences of good work, everywhere of thorough work, are to be found.

#### IMPERATIVE DEMANDS.

The time has arrived, however, when, in the judgment of the members of the Water Board, additional and necessarily heavy outlays must be made to meet the increased demands of immediate years, as well as to secure absolute safety for the present. It should be known to you that the wells from which the pumps at the Pumping Station draught water are supplied by means of a 30-inch main, extending from the vicinity of Beaver Brook to the pump wells, a distance of about 6630 feet. The limit of this pipe's discharge is 9,000,000 gallons per day. In view of extra demands that have been made at

times in the past, and that are likely to be made again, this is not sufficient, and as a matter of fact is not equal to the full capacity of the Morris and Worthington engines' combined pumping. But the worst feature of the situation is that the entire city's supply is dependent upon this single line of pipe. A break on this 30-inch main, although not expected, may occur at any moment. Such a mishap would cause the city to be dependent upon the contents of the reservoir for water, until the damages were repaired. Such mishap would cause great inconvenience to the people of Lowell, if not result in calamity.

The possibility of such an occurrence should not exist. The 30-inch pipe, together with the 24-inch force main from the pumping station to the reservoir, should be duplicated. The expense, as estimated by the City Engineer, will be for the 30-inch pipe work, \$49,850; for the force main, a distance of 2515 feet, \$16,850, or about \$67,000 for the entire work. Until this work is done, we can not recommend any considerable lessening of the water rates from the present schedule. This, however, leads us to add, though not pertinent at this time, that such an outlay would not prevent your honorable body causing a much-needed revision of rates. There are changes that might be made, that would, we believe, make your rate schedule far more equitable than at present, more concerning which we desire to say

later. To resume: the duplicating of the two lines of heavy pipe alluded to, will be the first and most important step toward increasing the pumping facilities of the works. It needs not the saying, that within a few years, a third engine must be added to your power, even should the present engines continue capable of full duty.

First, then, the additional mains should be provided as a precaution and a guaranty of safety.

Second, for the reason and in anticipation of the increased pumping your Water Works will soon be required to do, this work should be no longer delayed.

#### REFUNDING OF WATER DEBT.

On Nov. 1st of the present year, \$1,300,000 of City of Lowell Water Bonds, bearing date of Nov. 1, 1870, become due. Upon this principal the City of Lowell during twenty years will have paid at time of maturity interest at the rate of six per cent., amounting to \$1,560,000. The "day of redemption" is at hand. The City of Lowell need not after the present year pay this enormously high rate of interest. In May, 1891, \$200,000 bonds additional and bearing six per cent. will be payable. All may be refunded at a greatly reduced rate, possibly as low as three and one-half per cent. This will reduce the annual expenditures on account of Water Works very materially. It does not come within the range

1



of our duty to effect and place a reissue of bonds, nor is it within our province to dictate as to the financial policy that shall follow, as to disposal of the very considerable sum which, after refunding, will be at the disposal of the proper authority. A wholesale reduction of rates should not follow certainly, without the most thoughtful consideration and fullest knowledge of the affairs in detail of the Water Works. Those upon whom the responsibility rests, however, will undoubtedly act upon this important matter only after mature deliberation.

#### CONSUMPTION AND QUALITY OF WATER.

The daily consumption of the year, as indicated by pumping, is 4,654,259 gallons, against 4,978,258 gallons in 1888. We believe the tendency to wilful and ignorant waste of city water, spoken of by our predecessors in the last annual report, has been checked in some degree. The daily pumping average would tend to show that fact, though climatic conditions may be largely accountable for the saving over the pumpage figure of 1888. The present Water Board have created an official, for an experimental period, whose duty it is to visit premises and make a thorough inspection of all fixtures. In case it is found that waste of water exists, either from faulty fixtures, or from allowed continuous running, the tenants are notified forthwith, also the

owners of the property. In most instances a second visit shows that the remedy has been applied and the evil abated. The official in charge of this work has, since April 23d, visited 5,411 tenements. In this number he has found 243 cases of leaking fixtures, 28 cases of wilful, careless or ignorant running to waste. Of the fixtures found at fault, 98 were water closets. Of these 98 water closets, 79 were direct-pressure closets. This leads us to re-iterate what has been many times before declared, that a direct-pressure closet should not be permitted. In no city in the world where proper attention is given to economic methods are they permitted. But so long as the city authorities refuse to assume the control of plumbing work performed in Lowell, they will continue to be found, and being in use, they will, as they ever have, continue to waste an immense volume of water.

The entering upon the last subject emphasizes all that has been said by the Water Board of 1888, urging that the City Council adopt some measure, whereby official oversight shall be had over the work of plumbing performed in Lowell. It is a ruinous policy to permit many of the irresponsible persons now doing alleged plumbing in Lowell to continue their havoc. Your property owners are permitted to be imposed upon, disease is encouraged, your pumping engines are forced to do needless extra labor—all largely attributable to an evil that could

be in a measure checked, if the City would assume official direction of this very important matter.

The quality of City of Lowell water is a matter that is always, as should be, uppermost in our minds. We will not undertake to guarantee the pureness of the river water in future years, neither vouch for its condition at the present time. While we believe we are a blest community, with our magnificent river and the water it furnishes, we prefer to offer the best of proofs obtainable, that you may draw your own conclusions. The work of the State Board of Health is entitled to first notice, but although promised the result of conclusions arrived at from their labors during the year 1889, we are unable to produce the same, much to our regret. Our own investigations, especially in the line of means and methods of improving our present supply, have been eminently satisfactory to ourselves. The Board, accompanied by the Superintendent and City Physician, have during the year visited New York city, Brooklyn, and Holyoke, Mass., where they have witnessed the practical workings of what are conceded to be the prominent mechanical filters before the public. It has given us a full realization of the great field and opportunities open to the one who shall produce a mechanical filter, capable of delivering pure water in sufficient quantity, in specified time. We are not fully convinced that the mechanical filter, at any price, exists to-day, that would meet the

needs of Lowell at the present time. Still it will be borne in mind that there are cities that have undertaken this task and are to-day filtering their supplies, though with, if not doubtful success, not with entire satisfaction. It is not for us to doubt the final accomplishment of successful filtration by mechanical means, but it is a matter calling for most careful study before making even an experimental trial upon our water. We refer your honorable body to the very able and interesting treatment of the subject by City Physician Gage, which accompanies our own report.

Springfield, Mass., on the subject of mechanical filtration, say: "With the limited information we now possess as to the best mode of purifying our city-water supply, we do not feel justified in recommending any plan for filtration, at present. It is presumed, however, that the near future may develop some mode of purifying our water supply that will be effectual and less expensive."

The City of Brockton, Mass., has experimented with a mechanical filter (a Jewell filter using alum), and following their experiments they say: "At present we are unwilling to recommend the expenditure of any more money in this direction [ditching as recommended by the State Board of Health], as we believe that some system of purifying water by filtration will soon be inaugurated, that will be prac-



ticable in design, thorough in its work, and simple in its construction."

Further they say: "As we have said before, our experience with the Jewell filter was very gratifying to us; the water after passing through it being very transparent, bright, and sparkling, the taste pleasant and agreeable, and except for the statement in the report of the State Board of Health 'that they could not advise the use of water which had passed through and dissolved such an amount of alum,' we should unhesitatingly recommend the use of some mechanical filter for the City of Brockton."

To return to the condition of Merrimack-river water: no hasty generalization can determine the wholesomeness of drinking water. While the subject requires the closest observation and careful thought, it seems at times the more study, the more perplexing became the subject. The testimony of experts, too, is so contradictory at times, that the ordinary mind tires of the subject; and still again it is impossible to fix any standard which would apply to all waters. Those who love to dwell upon the quality of City of Lowell drinking water have certainly much to consider before arriving at conclusions final. To illustrate we quote:

"A water containing .005 part of albuminoid am-

monia, together with a considerable quantity of free ammonia, is suspicious, but in the absence of free ammonia, the albuminoid ammonia may be allowed to amount to something like .01 part. Above .01 should be regarded as very suspicious, and according to Wanklyn, over .015 part should condemn the water." (Nichols, Water Supply, 1883.)

Yet the same author says in another place: "To fix, however, a definite standard which would apply to all waters, and by which any one can judge of a given water from the numerical results of analysis, is impracticable. Every doubtful water must be considered by itself, with all the light that can be brought to bear upon it." . . .

"If the water is grossly polluted or is of exceptional purity, chemical examination can determine these facts; but in a vast majority of cases, while chemistry may teach something and aid in the decision, it can not teach every thing, and it can not decide. Now it would be very convenient if it were possible to take each item which is made the object of analytical determination and say that a good water may contain so much, and if a water contains more, it is not good.

This is impossible; a certain amount of the same substance might in one case be a sign of fearful contamination, while in another it might indicate only a normal constituent of the water."

Wm. T. Sedgwick, PH. D., of the Massachusetts

Institute of Technology, says: "We have yet a great deal to learn, however, about the algæ, the sponges, the infusoria, the rhizopods, and the higher forms of life which inhabit or infest (if you please) the sources of our water supply. These are things which pave the way for bacteria, by supplying them with food in the shape of their own dead bodies or their excreta, as organic matter subject to be decomposed. And yet these same organisms are not by any means wholly bad—they, too, in some cases at least, remove from the waters undesirable matters; so that to praise or condemn, in any given case, requires all the knowledge, the skill, and the common sense that an expert biologist can command."

To sum up what we have to say concerning purity of our water we must come to this conclusion, that even the chemists can not determine whether any insidious germ of transmissible disease, deposited in stream or lake, has been eliminated in transit. So, as a very practical, though not scientific, authority has said, "We must regard the water, as it is drawn from our service pipes, in the light of the closest analysis known to science, as pure or impure, according to the standards of purity which are practicable in connection with large water supplies, and not by an ideal standard of purity—such as would be afforded by the bubbling spring on the mountain side of a wild country."

We are satisfied that the City of Lowell is en-



joying the privilege of good water. Would that we had the guaranty of as good water for the future!

#### METERS.

The department has set during the year 155 meters. Of this number 68 are meters set by consumers who had formerly paid for water supply under rate schedule. Of the balance of the number, 73 are new water accounts, and 14 are set under the order of the Water Board. By these figures you will understand that the department has set almost double the number of meters of any previous year in the history of the Water Works. The total number of meter accounts upon our books numbered, Jan. 1, 1,757. By this is meant, meters through which water is measured and paid for at metered rates to the City Treasurer. Besides this number, there are in the city 38 meters, called "private," which are set inside a first meter for convenience of owner of property. There is no question but that hundreds of our property owners can save themselves money by placing a meter upon their premises. There are cases where there would be no saving, but such cases are dwellings with ordinary fixtures, or tenement property of such a character or with plumbing such as to form no fair basis for argument. In earlier days, the meter problem was looked upon as fol-

lows: if a meter upon the premises saves money for a consumer, the City necessarily loses just that amount of income. The question of how much water was run to waste under the rate charge was not considered. The problem of to-day is not as to how can the department make the most money, however, and citizens should know, many of them, that they can save money, when they are very considerable users of water, by use of meters. Our office officials are employed to give information upon the matter, and will be glad so to do at any time. The large increase in the number of meter accounts during the past year would indicate that citizens are giving thought to the matter. All will agree that the just way to sell water is by measure. All will agree that every citizen should be upon the same basis. No one, except possibly the manufacturer, will presume that meters as yet are absolute in reliability. But there are meters safe to buy, which, with proper attention, are capable of years of good service. It is a singular fact, that while the ordinary citizen views with suspicion the dial of a water meter, the Water Works official is just as apprehensive, and with more cause, lest, by the failure of the mechanical part, the meter will fail to register, though continuing to deliver water. The department's safety is wholly dependent upon the alertness of its officials, while the consumer, if he will protect himself against leaks and waste, is

assured reasonable water-bills and perfect satisfaction. Brookline, Mass., where they have recently adopted a rental-meter system, in their recent report truthfully say: "It is of course too early to speculate upon the effect of this primary step, with either our water waste or revenue. These facts, however, are surely established, namely: that our present system of assessing water rates by fixtures is illusive, inequitable, and fictitious, and that the meter, with its many supposed defects, is the best device known to-day for determining an approximate water consumption and adjusting an equitable charge therefor."

Innumerable are the opinions that might be quoted in sustainment of the meter system. Sandusky, O., say this through their water department: "In short, the only way to do, it seems to us, is to put all consumers on the same basis, that is, make each one pay for what he uses, making the rate low, if you choose, but charging all according to the amount used. The only way to determine what each uses is to measure it. The old cry that meters are not reliable is all moonshine and a thing of the past."

Pawtucket, R. I., possessed of water-works skill recognized everywhere, say: "While the question of the general use of meters has been held with difference of opinion in the past, we have advocated meter measurement first, last, and all the time.

It is convincing proof that we were not in error when we saw the opponents from year to year falling into line, and stating that something must be done to stop the wilful waste of water, so large expenditures for pumping machinery and supply were inevitable, and acknowledge that the remedy is in a general use of meters."

In several instances in our own experience, when it has been discovered that a wholesale waste of water existed, and when after notification the waste was not corrected, meters have been set by order of the Board, and at the expense of the City. It is needless to state that the remedy never fails. One notable instance, where, during the cold days of last winter, water was running at an annual amount equal to over \$1500, and rates were paid for same amounting to less than \$200, a meter was ordered set. The result is that this property since that time, by meter rates, uses less than \$50 per quarter.

As we have stated, we do not advocate an immediate reduction of rates.

It will be seen by the table which follows, that Lowell rates are not excessive, as compared with other cities.

Cities.	Family Rate.	Pan Closet.	Bath Tub.	Wash Bowl.	Wash Tub.	Horse and carriage, with use of hose.	Cow.	Hose.	Total.
Meriden, Conn.....	\$ 5 00	\$ 3 00	\$ 2 00	.....	.....	\$ 3 00	\$ 1 00	\$ 3 00	\$17 00
Wallingford, Conn..	5 00	3 00	3 00	.....	.....	3 00	1 00	3 00	18 00
New London, Conn..	5 00	3 00	3 00	.....	.....	2 00	2 00	2 50	17 50
Yonkers, N. Y.....	10 00	2 00	3 00	1 25	2 00	2 00	2 00	2 50	23 75
New Bedford, Mass..	2 50	2 50	2 50	1 25	.....	4 50	50	2 50	16 25
*Boston, Mass.....	7 00	2 50	2 50	.....	.....	6 00	.....	5 00	23 00
Pawtucket, R. I.....	7 50	.....	.....	.....	.....	4 00	1 00	6 00	18 50
New Haven, Conn...	6 00	3 00	3 00	.....	.....	6 00	1 00	3 00	22 00
Northampton, Mass.	6 00	2 00	2 00	.....	1 00	2 00	1 00	5 00	19 00
Portland, Maine.....	13 00	6 00	5 00	2 00	3 00	8 00	.....	5 00	42 00
Columbus, Ohio.....	9 00	3 00	3 00	.....	.....	3 50	.....	5 00	23 50
Lawrence, Mass.....	5 00	4 00	3 00	2 00	2 00	3 00	1 50	2 50	23 00
Lynn, Mass.....	6 00	5 00	5 00	2 00	2 00	5 00	1 50	3 00	29 50
Fitchburg, Mass. ...	6 00	5 00	5 00	2 00	1 00	8 00	2 00	5 00	34 00
Newton, Mass.....	6 00	5 00	5 00	.....	.....	10 00	1 50	5 00	32 50
Cambridge, Mass....	7 00	6 00	6 00	2 50	2 50	5 00	2 00	10 00	41 00
Providence, R. I.....	6 00	5 00	5 00	.....	.....	4 00	1 00	5 00	26 00
Taunton, Mass.....	5 00	5 00	3 00	2 00	2 00	4 00	1 50	5 00	27 50
Lowell, Mass.....	6 00	4 00	3 00	.....	1 00	4 00	2 00	3 00	23 00
Fall River, Mass.....	5 00	5 00	5 00	2 50	2 50	4 00	1 00	6 00	31 00
Brooklyn, N. Y.....	16 00	2 00	.....	.....	.....	5 00	75	5 50	29 25
Albany, N. Y. ....	18 00	2 00	.....	.....	.....	3 00	.....	8 00	31 00
Buffalo, N. Y.....	20 00	8 00	5 00	.....	.....	4 00	1 50	6 00	44 50
Niagara Falls, N. Y..	9 00	3 00	3 00	.....	.....	3 00	1 50	6 00	25 50
Detroit, Mich.....	7 00	3 00	2 00	.....	.....	4 00	1 00	3 00	20 00
Cincinnati, Ohio.....	14 00	3 00	6 00	1 00	.....	5 00	.....	4 80	33 80
Cleveland, Ohio.....	10 00	5 00	2 50	.....	.....	2 50	.....	1 50	21 50
Chicago, Ill. ....	19 00	5 00	3 00	8 25	.....	4 00	.....	3 00	42 25
Philadelphia, Pa.....	8 75	2 00	3 00	1 00	1 00	3 00	.....	9 00	27 75
Salem, Mass.....	3 50	5 00	5 00	1 50	.....	6 00	1 00	3 00	25 00
Springfield, Mass....	8 00	4 00	4 00	.....	.....	4 00	2 00	5 00	27 00
Concord, N. H.....	6 00	3 00	3 00	1 00	.....	2 00	1 00	3 00	19 00
Hartford, Conn.....	5 00	3 00	1 00	.....	.....	4 00	1 00	5 00	19 00

\* City of Boston reduced rate Jan. 1, 1880, seven per cent.



Though the rates as a whole compare favorably with any city, cost of pumping considered, a revision is loudly called for, that much that is now rank injustice may be made equitable. This could be done and not materially lessen the income of the department.

#### CONDITION OF PLANT.

As stated, the Water-works plant is in a very creditable condition; new wagons have been added during the year, so that to-day our stable equipment is complete. The river front of the filter basin has received attention, the past year, something long needed. The utility of the entire filter-gallery system as constructed may be questioned, as it is by many; nevertheless, to allow that portion of the basin fronting the river to fall into decay, permitting at seasons of high water the unrestricted flow of the river, not to speak of the appearance and consequent reflection upon the City, was a condition of things the Water Board of 1889 could not permit to continue. At an expense of less than \$1,000, following plan prepared by the City Engineer, a heavily timbered front or coffer-dam has been constructed, which it is expected will prove a successful barrier against inroads by the river, as well as to greatly improve the general appearance of the City property in the vicinity. Other portions of the property under your own as well as

the public eye, speaks for itself, and in a manner, we think, that reflects no discredit to the City.

#### PUMPING STATION.

The pumping station has been under the charge of Mr. J. P. Roberts, during the year. Records kept by the engineer show the total amount of water pumped into the reservoir during 1889 was 1,691,804,700 U. S. gallons, against 1,822,042,490 gallons in 1888, a decrease of 130,237,790 gallons in 1889, or a daily consumption average of 4,654,259 gallons in 1889, against 4,978,258 in 1888.

The total consumption of coal at the pumping station for all purposes amounts to 1558~~788~~ tons against 1800~~778~~ tons in 1888. The engineer accounts for this saving of coal by the fact that he has been able to run the Morris engine nearly the entire year; the only accident that happened being the breaking of keys during the month of December. Of the entire pumping, the Morris engine performed more than 95 per cent. of the work. This is an admirable showing and reflects credit upon the engineer and his assistants, for their care and watchfulness, night and day throughout the year.

#### COAL AND IRON-PIPE CONTRACTS.

In the regular routine of our business the heaviest purchases are for coal and cast-iron pipe.



So it has been during the past year. All such contracts have been awarded after competitive bidding, to the lowest bidder. The following covers the year's purchases for coal and heavy iron pipe:

OF D. W. HORNE & SON:

$21\frac{1}{2}\frac{17}{40}$  tons Cumberland coal, at \$4.75.

$438\frac{1}{2}\frac{10}{40}$  tons Cumberland coal, at \$4.89.

OF W. E. LIVINGSTON:

$112\frac{1}{2}\frac{60}{40}$  tons Cumberland coal, at \$4.75.

$654\frac{1}{2}\frac{25}{40}$  tons Pocahontas coal, at \$4.75.

OF DONALDSON IRON CO.:

5	tons	4-in.	cast-iron pipe,	at	\$28.03.
50	"	6-in.	"	"	28.03.
25	"	8-in.	"	"	28.03.
25	"	12-in.	"	"	27.53.
150	"	6-in.	"	"	28.31.

OF GLOUCESTER IRON WORKS:

150 tons 6-in. cast-iron pipe, at \$27.91.

OF R. D. WOOD & CO.:

100 tons 10-in. cast-iron pipe, at \$27.84.

There is at the pipe-yard at the present time, of the various sizes of cast-iron pipe, 233 tons. The fact that so large amount has been carried over to another year has invited criticism. The price of pipe during the year was unusually low, as will be seen from figures we have quoted. But aside from

the question of whether or no it is wisest for the department to exist in a hand-to-mouth fashion, or to carry a supply of material sufficient to meet any and all possible calls, the fact exists, that what was over-bought during the year has already proved a good investment. It is sufficient to say that we could not buy this same pipe to-day for less than from \$34 to \$35 per ton. By another summer it is not unlikely it will be even higher. Such fact stated, we think sufficient answer to criticism concerning the business policy of the department, in this direction.

ARNOLD S. WELCH,  
ARTHUR F. SALMON,  
MILES F. BRENNAN,  
JOHN STOTT,  
GEO. A. SCRIBNER.

## EXPENDITURES.

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### Paid for Sundries:

Abbot Downing Co.....	\$ 485 00
American Express Co.....	4 20
American Bolt Co.....	80 67
Adams, Charles E.....	1,640 14
Adams, J. J.....	34
Allen & Son, Otis.....	20
Atwood, W. P.....	38 00
American Frost Meter Co.....	1,079 00
Bacheller, Dumas & Co.....	251 60
Badger, F. S.....	1 75
Barker Manufacturing Co.....	2,637 59
Boston & Maine Railroad.....	670 75
Boutwell Brothers.....	47 59
Bolton, T. M., & Co.....	10 15
Boston & Lowell Railroad.....	3 85
Bartlett & Dow.....	3 10
Badger & Kimball.....	3 50
Builder's Iron Co.....	702 45
Burnham, Forrest & Davis.....	97 94
Brown, B. G.....	46 25
Brigham, C. W.....	2 75
Bean, C. S.....	14 32
Cahill Brothers.....	7 75
Cahill, Owen.....	19 20
Carleton & Hovey.....	6 75
Church & Son.....	55 02
Coburn, C. B., & Co.....	481 78

## Paid for Sundries:

Coggeshall, F. P.....	\$ 4 20
Cole & Nichols .....	9 42
Costello & Co.....	2,669 93
City: Appropriation Roads and Bridges .....	277 09
Appropriation Public Buildings.....	56 83
Appropriation Sewers .....	25 00
Appropriation Fire Department.....	30 00
Appropriation Reserved Fund.....	173 62
Clark, Thomas .....	8 95
Chapman Valve Co.....	898 28
Cameron, Amberg & Co.....	42 90
Clapp, Charles .....	3 00
Coburn, C. G.....	13 50
Campbell & Hanscom .....	14 70
Citizen Newspaper Co.....	24 00
Cheney, C. J.....	1 10
Critchett, James.....	2 00
Conant, C. P.....	121 90
Charon, Moses.....	21 75
Desper, W. E., & Co.....	280 88
Donovan, J. J., & Co.....	30 90
Derby & Co .....	1 50
Draper & Co.....	59 90
Donaldson Iron Co.....	7,156 38
Duckworth, John.....	5 15
Duren, T. E.....	20 00
Davis & Sargent.....	14 69
Engineering Record .....	6 00
Ebert, H. F .....	23 15
Erskine, Charles M.....	16 43
Farrell & Conaton .....	82 93
Foye, W. P.....	47 69
Fay Brothers & Hosford.....	9 82
French & Puffer.....	8 25
Gage, Daniel.....	49 50
Gates & Sons.....	11 46
Glover, W. B.....	4 60
Goulding, Robert.....	4 10
Globe Gas Light Co.....	4 00

## Paid for Sundries:

Gloucester Iron Works .....	\$4,191 20
Gibson, Moses .....	78
Howe Brothers & Co. ....	986 54
Holmes, Mark, & Son .....	6 00
Hanson, C. H., & Co. ....	304 00
Hersey Meter Co. ....	28 50
Horne, D. W., & Son .....	2,325 20
Howard & Wilson .....	1 40
Higgins, James .....	43 39
Harrington Brothers .....	12 00
Jacobs, J. H. ....	7 00
Jones, S. H. ....	21 43
Knapp, Charles L., Clerk .....	258 14
Knapp, Joel, & Son .....	2 50
Kittredge, A. L. ....	10 54
Leavitt, E. D. ....	25 00
Livingston, W. E. ....	3,743 03
Lovejoy-Paul Express .....	15 40
Lowell Rubber Co. ....	1 75
Lowell Cab Co. ....	1 00
Lawrence, Alvin .....	85 75
Lowell Gas Light Co. ....	99 16
Lowell Electric Light Co. ....	155 00
Lowell Rubber Type Foundry Co. ....	11 50
Libby, M. V. B. ....	12 30
Lyon Pen Co. ....	6 00
McGlynn, M. ....	5 00
Morse & Sparks .....	3 00
Mack, W. A., & Co. ....	11 75
Merrill, J., & Son .....	11 93
Miller, Joseph .....	153 40
Miller Brothers .....	4 50
Merrimack Rubber Co. ....	26 10
McDonald, T. J. ....	15 55
Morrill, F. L. ....	1 50
National Meter Co. ....	3,854 60
New England Telephone and Telegraph Co. ....	228 91
New York and Boston Express .....	8 05
Nichols, William, & Co. ....	1 40

## Paid for Sundries:

Proprietors Locks and Canals.....	\$ 51 68
Pevey Brothers .....	95 02
Perrin, Seamans & Co.....	97 00
Parker, W. H., & Son.....	3 50
Pratt, A., & Co.....	17 29
Pendexter & Farley.....	22 50
Page Belting Co.....	100 00
Ripley, Joseph.....	5 00
Reynolds, T. J.....	18 40
Rollins, F. E.....	15 19
Rice & Co.....	35 70
Scannell & Wholey.....	816 86
Smith, A. L.....	25 76
Smith, M. B.....	115 35
Shattuck, H. B.....	46 50
Staples Brothers.....	1,378 97
Stewart, J. W., & Co.....	75
Smith, James .....	7 90
Sheppard & Sons .....	19 55
Sherman, W. A.....	2 00
Snow, R. D.....	4 50
Swann & Smith.....	35 00
Sawyer Carriage Co.....	195 35
Smith, S. C. & G. H.....	1 68
Smith, E. A. & A. T.....	123 31
Stanton & Thurston.....	6 75
Sparks, J. H.....	9 50
Taylor, F., Co.....	323 19
Taylor, T. W.....	205 00
Talbot Chemical Co.....	2 80
Thompson, C. C.....	4 90
Union Iron Foundry Co.....	147 14
Vox Populi Press.....	145 25
Western Union Telegraph Co.....	4 67
Wilder, H. H., & Co.....	198 63
Whittier Machine Co.....	263 40
Walworth Manufacturing Co.....	111 58
Worthington, H. R.....	573 65
Wood, E. N., & Son.....	78 03

## Paid for Sundries:

Warburton Brothers.....	\$ 30 50
Wheeler & Co.....	3 08
Whithed & Co.....	2 30
Wilson, F. T.....	4 00
Wright, M. F.....	39 20
Whittet & McDonald.....	8 20
Wood, R. D., & Co.....	2,797 18
Warren & Co.....	6 00
Washburn, C. D.....	3 87
Water Waste Prevention Co.....	308 83
Ward, W. H.....	7 25
Zimmer, C.....	1 00



The following Table will Show the Expenditures and Receipts of the Works from 1873 to 1890, exclusive of Interest on the Water Debt.

	Expenditures.	Receipts.	Expenditures in excess of receipts.	Receipts in excess of expenditures.
1873.....	\$188,376 59	\$ 57,739 48	\$130,637 11	
1874.....	128,105 63	80,625 65	47,479 98	
1875.....	170,095 78	94,908 14	75,187 64	
1876.....	115,012 24	98,815 54	16,196 70	
1877.....	53,988 72	100,826 63	.....	\$ 46,837 91
1878.....	49,900 15	104,142 87	.....	54,242 72
1879.....	42,157 82	110,185 34	.....	68,027 52
1880.....	45,031 59	123,740 49	.....	78,708 90
1881.....	121,601 27	128,053 97	.....	6,452 70
1882.....	64,525 92	140,397 96	.....	75,872 04
1883.....	65,673 23	152,582 99	.....	86,909 76
1884.....	64,982 71	154,437 55	.....	89,454 84
1885.....	64,030 24	157,956 79	.....	93,926 55
1886.....	51,808 52	168,757 53	.....	116,949 01
1887.....	62,236 05	178,234 29	.....	115,998 24
1888.....	75,234 73	183,127 37	.....	107,892 64
1889.....	80,554 68	189,247 66	.....	108,692 98

# Charges for Water by Months, from Commencement to Dec. 31, 1889.

MONTHS.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.
January.....	.....	\$ 363 94	\$ 418 96	\$ 150 45	\$ 126 51	\$ 169 14	\$ 282 44	\$ 233 73	\$ 182 58
February.....	.....	35 53	235 43	238 85	86 84	144 38	238 19	349 08	146 40
March.....	\$6,124 94	50,200 10	65,417 68	82,249 51	89,177 52	82,225 43	80,603 69	80,567 44	89,210 88
April.....	785 89	1,739 50	935 20	265 34	584 11	1,970 12	9,242 84	6,478 39	540 20
May.....	2,988 16	3,274 09	2,147 96	874 47	1,819 65	1,121 43	2,751 35	1,476 15	879 61
June.....	5,818 78	2,865 86	2,887 43	4,460 91	2,389 52	3,903 69	6,126 86	868 08	12,574 12
July.....	4,833 52	1,889 03	1,926 31	582 68	3,147 78	1,261 24	1,213 13	11,457 84	273 00
August.....	2,728 30	498 50	449 86	771 87	799 88	677 01	563 35	459 17	514 46
September.....	2,827 07	3,245 06	865 90	495 97	3,493 90	4,998 07	6,584 86	8,108 23	10,088 19
October.....	9,729 05	872 10	2,947 93	4,893 44	543 79	663 80	454 29	338 51	309 22
November.....	761 21	634 03	573 35	1,445 65	518 72	1,220 27	1,405 89	620 56	873 16
December.....	1,571 72	3,689 79	3,955 59	3,246 39	4,040 71	4,522 75	5,794 77	7,851 52	9,593 32
Totals.....	\$39,168 64	\$69,307 39	\$82,861 60	\$99,674 93	\$98,178 93	\$102,877 32	\$115,261 20	\$118,808 70	\$125,975 27
Less abatements } to date,	.....	1,872 83	640 06	8,185 88	2,502 65	4,343 13	9,590 05	1,702 13	3,766 88
Net amounts.....	\$39,168 64	\$67,434 56	\$82,221 54	\$91,489 05	\$95,676 28	\$98,534 19	\$105,671 15	\$117,106 58	\$122,208 39

MONTHS.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January.....	\$ 233 37	\$ 271 52	\$ 472 76	\$ 702 05	\$ 410 21	\$ 427 66	\$ 454 33	\$ 420 32
February.....	139 22	136 06	347 66	352 90	439 68	439 98	343 06	495 71
March .....	90,856 37	94,956 65	98,692 13	102,991 30	104,537 77	111,281 68	110,812 26	114,110 39
April .....	403 64	263 10	351 73	439 64	1,355 01	773 67	536 02	1,219 74
May .....	1,191 41	984 84	1,495 90	1,062 34	1,760 48	2,057 80	1,750 52	2,618 47
June .....	16,401 62	17,757 44	18,709 27	21,203 61	23,768 43	23,017 09	26,090 68	25,322 78
July .....	959 80	1,069 37	899 21	1,053 36	1,434 99	2,383 37	1,781 40	1,328 39
August .....	634 40	902 76	984 17	828 40	1,173 44	927 65	1,072 41	1,273 06
September .....	10,904 30	12,467 32	12,939 94	13,452 97	16,105 05	18,397 55	16,773 25	16,288 39
October .....	552 27	941 81	738 12	697 87	783 29	1,108 16	1,414 52	1,107 60
November.....	378 97	1,615 65	693 41	477 10	686 02	683 55	937 19	874 11
December .....	10,848 08	12,512 70	12,544 55	12,617 45	12,826 41	15,927 35	14,476 76	15,096 53
Totals .....	\$133,503 45	\$143,869 22	\$148,028 85	\$155,848 98	\$165,279 78	\$177,425 51	\$176,442 40	\$180,155 49
Less abatements to date.....	2,490 50	3,094 15	4,314 79	3,946 34	2,991 18	2,367 70	2,794 87	†5,414 91
Net amounts .....	\$131,012 95	\$140,775 07	\$144,614 06	\$151,902 64	\$162,288 60	\$175,057 81	\$173,647 53*	\$174,740 58

\* A reduction of \$6,064.00 is accountable, owing to reduction of annual charge for fire hydrants.

† Abatements represent errors in making charges, clerical errors, abatements voted by Water Board, etc. A large item is that of abated rates as charged in annual account, and abated on account of meters set during the year.

The following Table will Show the Gross Cost of the Water Works Yearly, from the Commencement of the Same to Jan. 1, 1890.

---

Expended in 1870.....	\$ 95,057 00
“ 1871.....	624,151 66
“ 1872.....	560,708 40
“ 1873.....	349,717 87
“ 1874.....	233,370 63
“ 1875.....	275,660 78
“ 1876.....	221,502 24
“ 1877.....	163,814 28
“ 1878.....	158,510 15
“ 1879.....	150,047 82
“ 1880.....	154,391 59
“ 1881.....	231,171 27
“ 1882.....	173,645 92
“ 1883.....	180,280 28
“ 1884.....	175,290 20
“ 1885.....	176,972 56
“ 1886.....	169,105 22
“ 1887.....	176,906 05
“ 1888.....	183,279 73
“ 1889.....	193,535 48
Gross Cost of Works to Jan. 1, 1890, .....	\$4,647,118 95
Receipts to Jan. 1, 1890.....	2,259,434 67
Net Cost of Works to Jan. 1, 1890.....	\$2,387,684 28

# 1889 Water Works Acco

Balance undrawn Jan. 1, 1889...

received into the treasury on

## WATER WORKS:

Sundry persons for water  
 Sundry persons for water  
 Sundry persons for water  
 Sundry persons for water  
 Sundry persons for water

Total expenditures in

Balance undrawn Jan.

## MAINTENANCE.

Labor and general expense account.	Labor.	Office salaries.
\$259 25	\$334 00	\$354 15
144 00	112 50	283 44
199 87	217 25	354 30
53 00	182 99	283 44
34 12	444 36	235 44
14 75	597 61	294 30
17 00	763 71	243 44
.....	626 38	304 30
.....	497 30	243 44
25 00	433 62	243 44
.....	607 46	304 30
.....	248 43	182 50
\$8746 99	\$5,065 61	\$3,326 50

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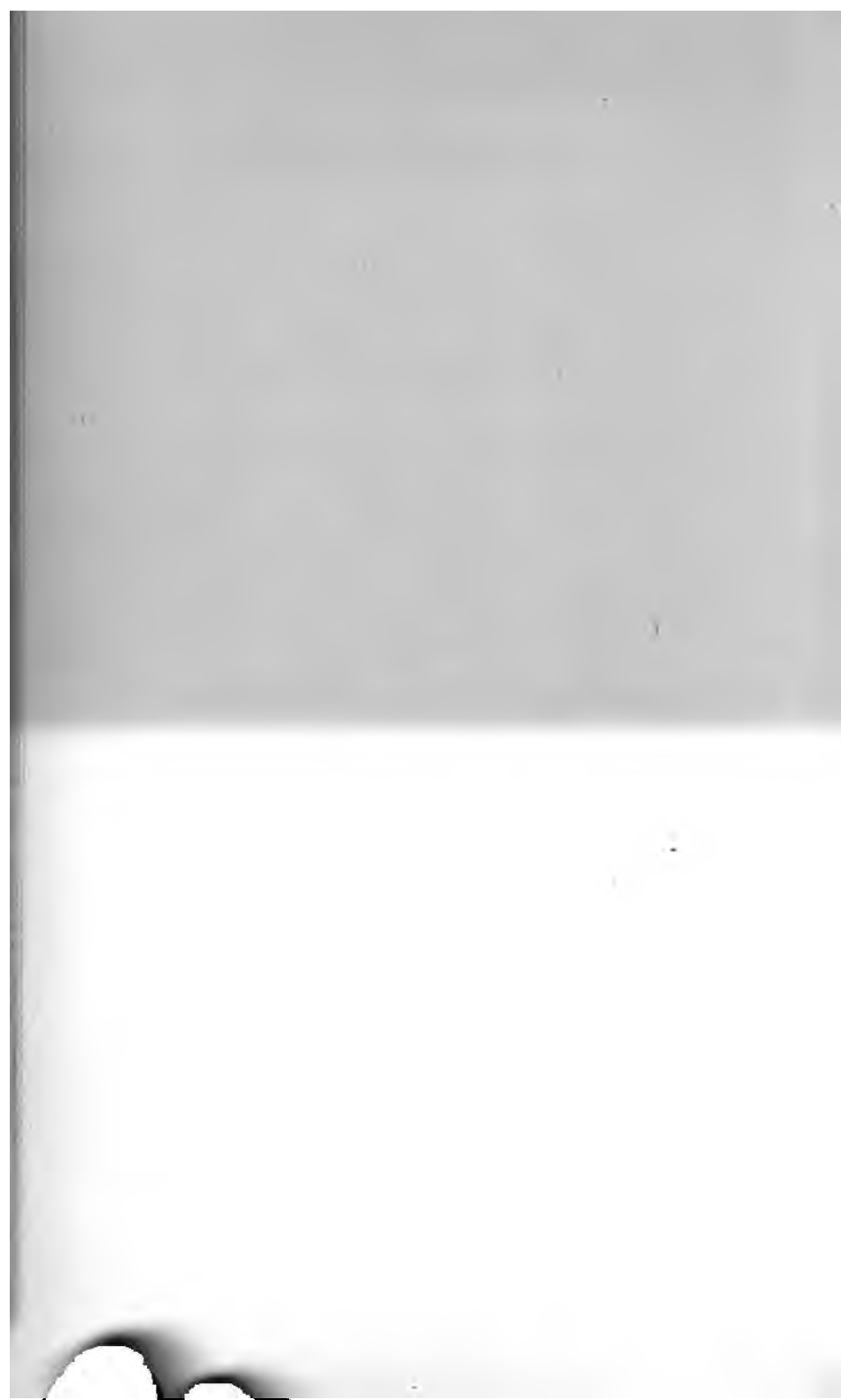
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## SUPERINTENDENT'S REPORT.





## REPORT OF THE SUPERINTENDENT.

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LOWELL, MASS., Jan. 1, 1890.

*To the President and Members of the Lowell Water Board:*

GENTLEMEN, — I herewith present the seventeenth annual report of the Superintendent of the Lowell Water Works, as required by the City Ordinance, for the municipal year ending Dec. 31, 1889.

### SUPPLY MAINS.

Work was commenced in this department on the 24th of March, and continued till the 14th of November. About eighteen to twenty men have been employed. There has been laid 20,510 feet cast-iron, which is a much larger number in feet than has been laid since 1877, when, in fact, the works were hardly completed. You will notice in the table that there has been very little pipe laid, smaller than 6-in. in diameter. I do not deem it advisable to lay smaller than 6-in., for it is of no practical use for fire purposes.

The longest line laid this year was on Pine street, which was 2048 feet in length. The people living on this

street have been calling for this extension for the past six or seven years. It will in a very few years serve a large number of water takers, as the City is extending in this direction very fast.

The Board of 1888 recommended the taking up of the 476 feet of 8-in. pipe on Middlesex street, between King and Garnet streets. The people of Ward Four have had some anxiety that, in case of a large fire, there would not be a sufficient supply of water, and also at the request of the Chief Engineer of the Fire Department, the 8-in. pipe was taken up, and 12-in. laid in its place, which will be of sufficient capacity for a number of years to come. It now makes a continuous line of 12-in. pipe through Middlesex street.

Although at the fire of the Lowell Horse Railroad Stables there was plenty of water, yet the owners of the large manufacturing establishments at the lower end of Howe street felt that a larger supply would be necessary; petitioned the Board that the 6-in. pipe laid in Howe street be taken up, and 10-in. laid in its place. The 24-in. main on East Merrimack street had to be cut out, and a 24x24x10 three-way set in. Although 407 feet of 10-in. pipe with one three-way, 6-in. post hydrant, and two four-way hydrants were set, yet the consumers were without water for only about eleven hours.

About 1125 feet of 10-in. pipe was laid on Rogers street, in anticipation of the growth of the City in that direction, which will be called into service for the use of the people living at the Oaklands, and possibly at some future day, at Atherton's.

300 feet of 6-in. pipe on White street, Pawtucketville, was lowered twenty inches on account of the Street Department cutting the grade down about the same. 1278

feet of wrought-iron pipe has been laid, making a total of 21,788 feet laid in 1889, or 4<sup>448</sup>/<sub>100</sub> miles.

It would be useless for me to say that there will not be many applications for extensions of mains the coming year, for the City is extending toward the City lines in all directions. And of course all will want City water.

#### NEW SERVICES.

356 new services have been laid; a larger number has not been laid since 1882.

11,587 feet have been laid, against 11,305 feet last year, which indicates the rapid growth of the City. But three iron services have been added, the past year. The amount of service pipe laid in 1889, is as follows:

$\frac{5}{8}$ -inch lead pipe.....	4,338 feet.
$\frac{3}{4}$ -inch lead pipe.....	4,894 "
1-inch lead pipe.....	1,615 "
1-inch iron pipe.....	354 "
1 $\frac{1}{2}$ -inch iron pipe.....	43 "
2-inch iron pipe.....	343 "
<hr/>	
Total laid during 1889.....	11,587 "
Amount previously laid.....	299,079 "
<hr/>	
Total amount now laid.....	310,666 "
Or 58 miles 4,426 feet.	

Total number of services put in... ..	8,471
Total cut off main.....	447
Total re-connected.....	26
Total now in use.....	8,050

## OLD SERVICES.

239 old services have been changed, measuring 8798 feet, against 7991 feet last year. I should recommend that the Board discontinue the laying of any iron services, for it is only the question of six to eight years when they will have to be relaid.

There have been about 100 old wooden sidewalk-boxes taken out and replaced with the new earthen boxes, so universally used in other places.

We have a large number of sidewalk cocks to dig up and repair or replace by new, owing to the use of the sidewalk wrench which so many plumbers and builders have. I would like to say, although knowing it would be of some inconvenience to plumbers and builders for a short time, that the only person to use a sidewalk wrench should be an employe of the Water Department. There is no knowing how many wrenches there are in the City held by outside persons, knowing how strict the office is to see that a new service is paid for before letting on the water. The only way to know that the building has not got water, is by an order from the office to let on the same. We are often called upon to let on the water for a new house, and to our surprise find that it has been left on by somebody owning a wrench which can be found in almost any blacksmith or machine shop. There have been cut off from the main 63 old discontinued services. This branch should receive more attention, for quite a number of the leaks reported during the year, are the result of leaving them connected. With the 356 new and 239 changes, making a total of 595, shows the largest amount of service-work done since the year 1873.

**Number and Kind of Services Changed During the Year 1889.**

SIZE OF SERVICE CHANGED FOR.		$\frac{1}{2}$ inch lead.	$\frac{3}{4}$ inch lead.	1 inch lead.	1 $\frac{1}{2}$ in. iron.	2 inch iron.	No. of feet.
27	$\frac{3}{4}$ -inch iron.....	1057	....	....	....	....	1057
140	$\frac{3}{4}$ -inch iron.....	....	4922	....	....	....	4922
60	$\frac{3}{4}$ -inch iron.....	....	....	2268	....	....	2268
8	1-inch iron.....	....	....	370	....	....	....
1	$\frac{3}{4}$ -inch iron.....	....	....	....	47	....	47
2	1-inch iron.....	....	....	....	....	90	90
1	1-inch iron.....	....	44	....	....	....	44
239	Total.....	1057	4966	2638	47	90	8798

Twenty-one new post hydrants have been set, all of the Chapman pattern. Two flush-hydrants have been taken out, and post-hydrants set in their place.

Quite a number of hydrants reported by the Chief of the Fire Department as being out of repair have been attended to. The main cause of their being out of repair, which we all know is by the improper handling by persons in the employ of the sewer and other departments. I would recommend to the Board, that there should be an employe of this department sent upon application from the Sewer Department in all cases where it is necessary to open a hydrant for flushing or other purposes; by so doing, all the water used could be metered, and it would also place the damage done to hydrants where it belongs; by doing this the Water Department will get what rightfully belongs to it, an accurate account of water used.

We have taken out four old wooden hydrant-boxes, and replaced them by four iron boxes which we had on



hand. Have taken out thirteen old wooden boxes, and replaced them by ones of the same material of kyanized lumber. There is a very important matter that should come before your Board: that is, selecting a hydrant-box of some indestructible material, to take the place of the wooden boxes that were placed when the works were built, and, after seventeen years of use, are now decaying very fast. Probably there will be from thirty to seventy-five old boxes taken out the coming year, and, of course, new ones will have to be set. The same may be said of gate-boxes.

#### GATES.

There have been twenty-eight gates set the past year, from 4 to 12 inches in size. It has been my custom to set a gate on each end of a street, so as to simplify the work of shutting off, in case of needed repairs. There should be several gates set next year on old lines, as it now requires a large amount of time to notify the consumers on the line when we are about to shut off the water for repairs or new connections.

#### LEAKS.

The department has been very fortunate in this respect. Only one leak of any magnitude has been reported the past year; that was caused by the laying of the Gorham-street sewer at the corner of London Street. Happening, as it did, in the daytime, but very little damage was done. It was repaired at once, and the people in the whole of Ayer's City were without water only about five hours. Five other leaks in mains have been reported, and the same attended to.

Several leaks in services have occurred, but no more than is usual, considering the large number of old iron



services in use. The leaks have been generally caused by the breaking of the old "goose-neck."

#### RESERVOIR.

The high-service reservoir has required but little attention the past year, but another year the fence will need some repair.

Not so with the Beacon-street reservoir. Practically a new fence has been built on three sides, which was very much needed. The fence and gate-house have been painted two coats; the stable at the keeper's house has been slightly changed, and the same received one coat of paint. There is a space of about four feet of grass-ground between the fence and the top of the embankment which should be concreted, to further the cleanliness, which the present Board has worked so hard to bring about. The concreting will prevent the dead grass and earth from finding their way into the water.

#### PUMPING STATION.

The pumping station has received two coats of paint; a guard has been placed about the Worthington pump as a precaution against accident to visitors.

The Morris engine pump has been run steadily until December 16th, when a slight break occasioned the starting of the Worthington for a few days, while the repairs were being made. The old Jacket boiler that has been in use since 1876 has given out, and a new one ordered to take its place at a cost of \$175. The pump-well has been cleaned out five times; each time more or less sediment was found.

1,691,804,700 gallons of water were forced into the low-service reservoir, against 1,822,042,490 gallons in 1888, a

reduction of 130,237,490 gallons, which was caused in the most part by the conditions of the weather, and partly through the efforts of Mr. Worthen, the inspector of leaks.

The Morris engine has performed 95.34 per cent., and the Worthington 4.66 per cent. of the total work. 22,372,498 gallons have been forced into the high-service reservoir, against 23,468,460 gallons in 1888, a reduction of 1,095,962 gallons. Mr. Roberts, the engineer, reports but a slight outlay on the pump and boilers. For other data, I most respectfully refer you to the report of Mr. Evans, the City Engineer.

#### CLEANING.

The question of keeping the supply in as wholesome and clean condition as possible, has received considerable attention during the summer months.

The mains have been blown off four times. We have changed the time of blowing off the mains from daytime until between 9 and 12 o'clock, P. M., which is a great improvement, as it will discommode fewer people, particularly elevators and laundries, where they use a large amount of water during the day. By so doing, it will allow the water in the mains to get pretty well settled before 7 o'clock in the morning.

A new pressure recording gauge has been placed in the office. The first night it was of much use to the department. On October 31st, at 9 o'clock, we opened the ten 6-inch blow-off pipes into the rivers and canals, which reduced the pressure to 17 lbs. At 9.50 o'clock, an alarm of fire was sounded, which of course necessitated the closing of all these gates, by men stationed at each for that purpose. In ten minutes the pressure

gauge recorded 47 lbs., and before the fire department would have had occasion to use water, the pressure would have been up to the 60 lbs.

#### FILTER GALLERY.

The filtering gallery has been thoroughly cleaned on July 29, 30, and 31. The pump was idle; all the water was drained from the gallery, but about eighteen inches. A large 8-inch centrifugal pump was got in Boston, with boiler and engine attached, placed at the man-hole near the inlet-basin, most of the water was pumped out; twenty men entered at the upper man-hole, and with brooms washed the top and both sides as clean as possible, keeping the bottom agitated all the time the pump was running. We were very much surprised to find so little silt and accumulations on the bottom. This work has been done but once since the construction of the works.

On the bottom of the gallery were found quite a number of springs, the temperature of which was found to be twenty-five degrees colder than the river water.

#### CONDUIT.

The brick conduit has received the same treatment as the gallery.

#### BEAVER BROOK CROSSING.

The 30-inch crossing under Beaver Brook has been blown out three times during the summer. There has been some anxiety expressed that there might be more or less sediment lying in the bottom of the pipe. On October 26th, all the water that could be, was drawn off. Then the services of a steam fire engine were called to pump out that remaining in. A man with a rope around

his body was lowered, and passed most of the way across, but nothing was found in the pipe. This is the first time this work has been done since the completion of the works.

#### FILTERING INLET.

Much care has been taken with this important part of the filtering plant. The basin has been drawn off five times; the sides and bottom have been scraped and cleaned of the silt that flows in from the river; about seventy-five loads of new sand have been put in. For the last ten years, or more, the several Water Boards have talked of building a dam on the river front. This year's Board voted to have the work done. It consisted of a frame of 10x10-inch spruce timber, covered with 6-inch plank, all kyanized lumber. It has been built at an expense of less than \$1000. The people who advocate pure water will never regret this outlay, for now it can be used earlier in the spring than heretofore; owing to the close proximity of the new Boulevard, another year a new fence of some ornamental pattern should be built around it to protect it.

#### MISCELLANEOUS.

The buildings at the pipe yard have received some attention. A new floor has been laid in the stable, a ventilator added. Heretofore there has not been a fit place to hang a harness, but we are in hopes to have a good room when the repairs are finished. A 6-inch pipe sewer has been laid to the main sewer, to carry away the waste water used for testing meters and other purposes. A water-closet has been put in. All of these improvements were very much needed.

The Board has visited the shop on Broadway, and of course you could not but notice the condition of the same. I can hardly see how they could do the amount of business that is required of them; every thing was thrown into boxes; if an article of repairs was needed, a man could hunt and, by chance, might possibly find what he wanted; but when the repairs that are now going on are finished, I am in hopes to show to the Board that the business should have been systemized years ago, and in my opinion save a large amount of money for the department, by holding somebody responsible for the material delivered to the meter, construction, or service departments.

Six-inch fire services have been laid for Otis Allen & Son on Mt. Vernon Street, Fay Brothers & Hosford for new theatre on Central Street, a 4-inch fire service for G. H. Marston's new block on Middlesex Street, and for the new Palmer-street engine house; also at elevator building for J. G. Sherburne.

An old flush hydrant was taken out from the yard of the Shaw Stocking Company, and a new post hydrant set in its place.

A new two-way post hydrant was set over at the Merimack Woolen Mills, for that company.

The consumers of water are just waking up to the idea that the proper way to use water is to meter it, so as to pay for only what is used, and the fact that the present Board places meters at the actual cost, has caused a larger number of meters to have been set than in any other year. The number of new meters set has been 155. The table below shows the number of meters, both regular and private, that are running at the present time:

## Meters Running Jan. 1, 1890.

SIZE IN INCHES.	$\frac{1}{2}$ in.	$\frac{3}{4}$ in.	1 in.	1 $\frac{1}{2}$ in.	2 in.	3 in.	4 in.	Motor Register.	Total.
Desper.....	423	145	56	....	....	....	....	....	624
Worthington..	268	25	48	69	30	8	3	....	451
Crown .....	183	277	110	1	6	....	1	....	578
Duplex.....	10	13	9	....	....	....	....	....	32
Ball and Fitts.	15	7	2	1	....	....	....	....	25
Fitts Rotary..	3	1	....	....	....	....	....	....	4
Frost .....	15	7	3	1	1	....	....	....	27
Thomson.....	1	9	2	....	....	....	....	....	12
Balance Valve.	....	1	....	....	....	....	....	....	1
Gem .....	....	....	....	....	1	....	....	....	1
Motor Register	....	....	....	....	....	....	....	2	2
Totals .....	918	485	230	72	38	8	4	2	1757

## Private Meters Running Jan. 1, 1890.

SIZE IN INCHES.	$\frac{1}{2}$ inch.	$\frac{3}{4}$ inch.	1 inch.	2 inch.	Total.
Desper .....	1	3	1	..	5
Worthington .....	..	..	1	1	2
Crown .....	7	13	1	..	21
Duplex.....	1	..	..	..	1
Frost .....	2	1	..	..	3
Thomson .....	4	1	..	..	5
Hersey .....	1	..	..	..	1
Total .....	16	18	3	1	38

Two 2-inch stand pipes have been set for street watering purposes, one on Nesmith Street, and one on Highland Street.

The question of better protection against fire is always before the people of the city. I see, in studying over the system of mains, that the center of the city is not, in my opinion, as well cared for as it should be. The fact exists that there is but a 6-inch main in Central Street, from Merrimack to Market Streets, where it comes to a dead end. The same should be said of Middle Street, where a 6-inch main runs about 350 feet, then an 8-inch the remainder of the way. Therefore, I would recommend to the Board, that a 16-inch (at least) be laid in Central Street, connecting at Market Street, and a 12-inch (at least) in Middle Street, connecting with Shattuck Street.

One of the large 30-inch drinking fountains has been changed from Bridge to First Streets, in front of land owned by the city, which change the people of Centralville are very much pleased with.

In conclusion, I desire to express my obligation to the President and members of the Water Board. Also to Mr. Knapp, the Clerk, and all other employes of the department, who have worked to make the department as efficient as it is to-day. Taken in all it has been the most prosperous year of the Lowell Water Works.

Most respectfully submitted,

MILLARD F. WRIGHT,

*Superintendent.*



## Low Service — Water Pipes Laid in 1889.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.					Total.
		4-in.	6-in.	8-in.	10-in.	12-in.	
Aiken.....	From River south-westerly.....					217	217
Bachman .....	Extended south-westerly.....		144				144
Barrington ..	From Andrews easterly.....		118				118
Cumberland road .....	Extended southerly towards En- nell .....		48				48
Congress .....	From Gorham north-westerly....		287				287
Columbus av.	Extended easterly towards Walk- er.....		48				48
D.....	From South Loring westerly.....		408				408
Dalton .....	From Exeter southerly.....		145				145
Dutton.....	Opposite L. M. S. Office.....		18				18
Eaton .....	Extended westerly from London ..		100				100
Eighteenth ..	From Beacon westerly.....		370				370
Emery .....	Westerly from Crescent.....		84				84
Earl.....	Extended southerly towards Lundberg .....	101					101
Exeter.....	From Dalton south-westerly.....		124				124
Exeter.....	From Dalton north-easterly.....		45				45
Forrest.....	From Stevens easterly.....		829				829
Foster .....	Pine and Westford.....		508				508
Foster .....	Westford and Princeton. ..		301				301
Fruit.....	Plain and Marshall road.....		572				572
Front. ....	Extended westerly.....		60				60
Fort Hill av..	Extended northerly towards Oak ..		48				48
Hanover.....	From Moody northerly.....		242				242
Hall.....	Extended westerly.....			72			72
Hanks.....	Sherman and Rogers.....		882				882
Harvard .....	Middlesex and Troy.....		651				651
*Howe .....	East Merrimack and Belvidere Woolen Mills' Yard.....				407*		407
Livingston av	From Princeton northerly.....		165				165
Ludlam .....	Extended easterly towards Bridge ..		121				121
Marlborough.	Pine and Westford.....		918				918
Maple .....	Extended westerly from Gorham ..		268				268
Manchester ..	Extended westerly towards Eaton ..		152				152
	<i>Carried forward.....</i>	101	7,726	72	407	217	8,563

## Low Service—Water Pipes Laid in 1889 (continued).

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.					
		4-in.	6-in.	8-in.	10-in.	12-in.	Total.
	<i>Brought forward</i> .....	101	7,726	72	407	217	8,563
†Middlesex...	Garnet and King.....					476†	476
Midland.....	Westerly of Chelmsford.....		119				119
Nesmith .....	Extended southerly to Rogers....		701				701
New Walker..	From D southerly.....		357				357
Nicollette av.	Extended from Stevens westerly..		195				195
Parker .....	From Pine southerly .....		116				116
Payton .....	Extended southerly of Plain.....		36				36
Perry .....	From Pond southerly.....			314			314
Perry .....	Extended southerly towards Sher- man.....			281			281
Perry .....	From Sherman southerly.....			321			321
Pine .....	Oakland and Westford.....		2,048				2,048
Pine Hill.....	From Kinsman north-westerly...		90				90
†Pond.....	Concord and Perry.....		15†	138			153
Princeton ....	Windsor and Livingston av.....		54				54
Puffer's Court	From Jewett westerly.....	186					186
Rogers .....	From Nesmith south-easterly.....				792		792
School .....	Rock and N. & L. R. R.....		375				375
Sherman .....	Concord and Perry.....		164				164
Sherman ...	Huntington and Hanks.....		159				159
So. Walker..	Liberty and Mason.....		890				890
So. Walker...	From D northerly.....		61				61
So. Loring....	From D northerly.....		84				84
Stevens.....	Extended southerly to Forrest....			23			23
Third av.....	From White south-westerly.....		149				149
Twelfth .....	From Wachusett easterly.....		36				36
Washington ..	Extended southerly.....		48				48
Wachusett....	From Twelfth northerly.....		70				70
Ware .....	Extended southerly.....		60				60
Walden.....	Extended westerly towards Par- ker.....		84				84
White .....	From Riverside north-westerly...		772				772
Whitney av...	From Beacon westerly.....		463				463
	<i>Carried forward</i> .....	287	14,872	1,149	1,199	693	18,040

### Low Service — Water Pipes Laid in 1889 (continued).

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.					Total.
		4-in.	6-in.	8-in.	10-in.	12-in.	
	<i>Brought forward</i> .....	287	14,872	1,146	1,199	693	18,040
Windsor.....	From Princeton southerly.....		144				144
Wilber.....	From Parker northerly.....		824				824
Worthen.....	Broadway and Fletcher.....		1,084				1,084
Worthen.....	Crossing Worthen, opposite pas- sage-way leading to L. M. S. yard.....	30					30
	Hydrants.....		186	22			208
Laid in 1889.....		317	17,123	1,171	1,199	693	20,510
*Less 6-inch taken out, Howe street.....							407
†Less 8-inch taken out, Middlesex street.....							476
‡Less 4-inch taken out, Pond street.....							15
Less total pipe taken out.....							898
							19,612
Low Service laid previous to 1889.....							433,992
Total Low Service to Jan. 1, 1890.....							453,604
Total High Service to Jan. 1, 1890.....							20,252
Total High and Low Service to Jan. 1, 1890.....							473,856
Total in miles.....89.75.							

### High Service — Water Pipes Laid in 1889.

STREETS.	BETWEEN WHAT STREETS.	LENGTH IN FEET.		
		6-in.	10-in.	Total.
Belmont av.....	From Talbot southerly.....	269	....	269
Fairmount.....	Extended southerly to Rogers.....	72	...	72
Hanover av... ..	From Sycamore northerly....	156	....	156
Parkview av... ..	From Col. C. A. R. Dimon's northerly...	968	....	968
Rogers.. ..	From Fairmount south-easterly.....		329	329
	Hydrants.....	7	....	....
	Laid in 1889.....	1,472	329	1,794
	High Service laid previous to 1889.....			18,458
	Total High Service to Jan. 1, 1890.....			20,252

## Low Service — List of Stop Gates Set During the Year 1889.

STREET.	LOCATION.	4-inch.	6-inch.	8-inch.	10-inch.	12-inch.
Congress .....	11 ft. north of south line of Congress, 1 ft. east of west line of Gorham.....		1			
Dutton.....	3.5 ft. north-westerly of south-easterly line of Dutton, 33.5 ft. north-easterly of passage-way opposite L. M. S. office.....	1				
Eighteenth...	12 ft. south of north line of Eighteenth, on west line of Beacon.....		1			
Foster.....	12 ft. west of east line of Foster, on north line of Pine.....		1			
Foster .....	7 ft. west of east line of Foster, 2.5 ft. north of north line of Westford.....		1			
Forrest.....	12 ft. south of north line of Forrest, on east line of Stevens.....		1			
Hanks .....	13.3 ft. west of east line of Hanks, on south line of Sherman..		1			
Hanks.....	15 ft. west of east line of Hanks, 10 feet north of north line of Rogers.....		1			
Harvard.....	14.5 ft. west of east line of Harvard, 4 ft. south of south line of Middlesex.....		1			
*Howe .....	12.5 feet east of west line of Howe, 1 ft. south of south line of E. Merrimac.....				1	
Marlborough.	12 ft. west of east line of Marlborough, 2 ft. north of north line of Pine.....		1			
New Walker..	14 ft. west of east line of So. Walker, on south line of D.....		1			
†Middlesex...	17 ft. north of south line of Middlesex, 2 ft. west of west line of Garnet.....					1
Middlesex....	18 ft. south of north line of Middlesex, 15.5 ft. west of east line of Harvard.....			1		
Nesmith.....	15 ft. west of east line of Nesmith, opposite Rogers.....		1			
Nicolette av...	12 ft. south of north line of Nicolette, 3 ft. west of west line of Stevens.....		1			
Parker.....	11.5 ft. west of east line of Parker, on southerly line of Pine.....		1			
Pine.....	15.5 ft. south of northerly line of Pine, 37 ft. east of east line of Marlborough.....		1			
Pond.....	20 ft. south of north line of Pond, on west line of Concord.....		1			
River.....	16.5 ft. west of east line of River, 24 ft. north-westerly of south-east line of Aiken .....			1		
Sherman .....	12 ft. south of north line of Sherman, on west line of Concord .....		1			
So. Loring....	12 ft. east of west line of So. Loring, on north line of D.....		1			



### Low Service—List of Stop Gates Set During the Year 1889 (continued).

STREET.	LOCATION.	4-inch.	6-inch.	8-inch.	10-inch.	12-inch.
So. Walker ...	13 ft. west of east line of So. Walker, on south line of Liberty.....		1			
So. Walker....	13 ft. west of east line of So. Walker, 1.5 ft. north of north line of D.....		1			
Whitney av...	13 ft. north of south line of Whitney, 1.5 ft. east of west line of Beacon.....		1			
White .....	12.5 ft. north-easterly of south-westerly line of White, 2 ft. north-westerly of north-westerly line of Riverside.....		1			
White .....	15 ft. east of west line of White, 20 ft. south-easterly of northerly line of White (near angle)..		1			
Wilder .....	14 ft. east of west line of Wilder, 2 ft. north of north line of Parker.....		1			
Worthen.....	14 ft. south-easterly of north-westerly line of Worthen, 41 ft. south-westerly from Broadway.....		1			
Worthen.....	14 ft. south-easterly of north-westerly line of Worthen, 3.5 ft. north-easterly of north-easterly line of Fletcher.....		1			
<b>High Service.</b>						
Fairmount ....	14 ft. east of west line of Fairmount, 24 ft. north of northerly line of Rogers.....		1			

\*Replaced 6-inch gate, Howe st.

†Replaced 8-inch gate, Middlesex st.

**Low Service—List of Hydrants Set During the Year 1889.**

STREET.	LOCATION.
D .....	North side, opposite New Walker st.
Foster.....	Easterly side, 141 ft. northerly of Pine st.
Forrest.....	Northerly side, 799 ft. easterly of Stevens st.
Fruit .....	Southerly side, 50 ft. westerly of Plain st.
Hanover.....	South-easterly side, 94 ft. northerly of Moody st.
Howe.....	West side, near the Belvidere Woolen Mills' yard.
Harvard.....	North-east corner of Troy st.
Marlborough.....	Easterly side, 423 ft. northerly of Pine st.
Perry.....	West side, 311 feet southerly of Pond st.
Pine.....	Northerly side, 527 ft. westerly of Foster st.
Pine.....	Northerly side, 584 ft. southerly of Westford st.
Rogers .....	Easterly side, 868 ft. southerly of Nesmith st.
School .....	Easterly side, 153 ft. north of the N. & L. R. R.
So. Walker.....	North-east corner of Liberty st.
So. Walker.....	Near north-east corner of Mason st.
White .....	North-westerly side, 28 ft. north-easterly of angle in street.
Wilder .....	West side, about 120 ft. north of B st.
Whitney av.....	South side, 147 ft. westerly of Beacon st.
Worthen.....	North-westerly side, opp. passage-way leading to L. M. S. yard.
Worthen.....	North-westerly side, 29 ft. north-easterly of Kitson st.
<b>High Service.</b>	
Parkview av.....	West side, opp. the residence of Henry J. Moulton.

## Property at Pipe Yard Jan. 1, 1890.

## CAST-IRON PIPE AND SPECIALS.

DIAMETER IN INCHES.	4	6	8	10	12	16	20	24	30
Lengths.....	5	489	84	188	9	3	17	6	4
Sleeves.....	1	12	3	3	2	8	5	8	7
Caps.....	14	2	24	3	16	3	1	1	....
Curves.....	5	....	11	2	5	4	10	4	....
Plugs.....	7	4	2	1	....	....	....	....	....

DIAMETER IN INCHES.	4x4	6x4	6x6	8x6	8x8	10x6	10x8	12x4	12x6	12x8	12x10	12x12	16x6	16x8	16x12	10x16	24x6
3-ways.....	3	..	6	1	6	5	1	1	1	1	..	1	1	1	..	..	1
4-ways.....	7	..	..	..	..	..	1	..	6	3	..	..	1	..	..	..	..
Reducers.....	..	2	..	5	..	3	4	..	1	..	2	..	..	..	1	..	..

Stop gates, 5 4-inch, 3 6-inch, 2 8-inch; wrought-iron pipe, 24 feet 1-inch, 36 feet 1½-inch, 288 feet 2-inch; 2 reels of ½-inch lead pipe, 3½ reels of ¾-inch, 3 reels of 1-inch; 6 ¾-inch tees, 15 1x½; 8 1x½ crosses; 20 1-inch, 20 1x½-inch elbows; 10 1x½-inch, 21 1½-inch iron unions; 12 2-inch; 6 2x1½ bushings; 20 reducing couplings; 24 1-inch plugs; 26 1-inch sidewalk cocks for lead; 58 1-inch sidewalk cocks for iron; 3 1-inch cellar cocks, 40 ¾-inch sidewalk cocks for iron; 34 ¾-inch sidewalk cocks for lead; 8 ¾-inch cellar cocks; 22 ¾-inch corporation cocks; 10 ¾-inch unions; 3 1-inch brass bushings; 24 1-inch corporation cocks, 4 1½-inch solder nipples, 18 ½-inch brass nipples; 20 ¾-inch unions; 16 2-feet iron sidewalk, 20 1-foot sidewalk boxes; 267 joints of earthen pipe for sidewalk boxes, 1 buck saw, 2 saw horses, 150 round collars, 108 square collars for sidewalk boxes, 1 machine for testing pipe, 2 pipe benches, 2 tool boxes, 2 derricks, 2 fall ropes, 2 set blocks, 7 draft chains, 12 wheelbarrows, 2 tongs for cleaning sidewalk boxes, 2 hydrant-frames, 8 hydrant-covers, 4 gate-box frames, 5 gate-box covers, 1 drinking fountain; 25 picks, 20 pick handles, 15 round-point shovels, 12 square-point shovels, 10 scrub brooms, 14 pair rubber-boots, 25 lanterns, 42 glass globes for lanterns, 30 feet rubber hose, 1 hose reel, 2 brass goose-necks, 6 calking sets, 4 hail-hammers, 100 sidewalk box caps, 100 feet canvas hose, 300 feet 2½-inch rubber hose, 9 6-inch S curves, 7 flush hydrants, 4 8-inch post hydrants, 9 6-inch post hydrants, 12 old style second-hand hydrants, 30 iron lugstraps, 250 lbs. assorted bolts, 10 assorted files, 9 assorted gravel screens, 25 lbs. cotton waste, 3 trowels, 10 lbs. iron washers, 30 lbs. assorted nuts, 3 hand hatchets, 2 axes, 5 sling ropes, 1 dualin pot, 8 striking hammers, 4 hand hammers, 3 paving hammers, 1,100 lbs. pig lead, 2 lead pots, 1 furnace for melting lead, 1 zinc pump, 3 copper force pumps, 1 keg 30d nails, 10 lbs. 10d nails, 40 assorted wrenches, 8 rammers, 3 paving mauls, ½ barrel cement, 20 lbs. white clay, 1 blacksmith shop, 1 work shop, 1 carriage house, 1 stable, 1 store shed, 3 spirit levels, 600 feet lumber for making gate boxes, 2 patterns for making gate and hydrant boxes, 1 set blacksmith tools, 300 lbs. steel in drills, 4 scrapers for blasting purposes, 4 lbs. pipe wedges, 3 yarning irons, 3 lead ladles, 7



crow-bars, 4 horses, 4 express wagons, 2 light wagons, 1 single truck, 1 double truck, 4 horse blankets, 4 street blankets, 1 buffalo robe, 1 duster, 2 pungs, 1 light sleigh, 3 horse brushes, 7 single harnesses, 1 double harness, 50  $\frac{3}{4}$ -inch lead connections, 4 horse halters, 4 hay forks, 2 manure forks, 2 wagon jacks, 2 wagon wrenches, 3 canvas covers for horses, 1 rubber cover for horse,  $2\frac{1}{2}$  tons of hay, 12 pipe tongs, 6 Stilson wrenches, 6 monkey wrenches, 4 tapping machines, 25 dippers for drinking fountains, 1 sewer block-tin dipper, 100 feet block-tin tubing, 2 24-foot ladders, 2 ratchet cutters, 3 pipe cutters, 20 dies, 2 ratchet die plates, 1  $\frac{3}{4}$ -inch tap, 1 1-inch tap, 1  $1\frac{1}{2}$ -inch tap, 75 feet block tin wire, 1 solder pot, 2 solder moulds, 2 charcoal furnaces, 1 naphtha furnace, 4 soldering irons, 15 gate spindles, 10 hydrant spindles, 16 hydrant valves, 2 hand rakes, 8 lbs. axle grease, 10 hoes, 30 hydrant packings for top, 30 packings for bottom, 60 assorted hydrant packings, 10 packings for 4-inch gate, 12 for 6-inch, 6 for 8-inch, 3 for 12-inch, 1 for 16-inch, 1 map distributing mains, 1 map showing stop-gates,  $\frac{1}{2}$  ton stove coal, 2 portable closets,  $\frac{1}{4}$  gross lampwicks, 1 blasting battery, 1 desk, 12 lbs. dualin, 1 pattern for S curves, 2 stone hammers, 250 lbs. plumbers' solder, 3 paint brushes, 3 paint pots, 1 marlin spike, 4 lights of window glass, 25 lbs. caulking yarn, 20 logs for blasting purposes, 1 10-gallon can, 1 Edison patent pump, 12 feet 4-inch rubber hose, 1 5-gallon can, 2  $\frac{1}{2}$ -gallon, 1  $\frac{1}{4}$ -gallon, 1 coal stove, 1 coal hod, 1 broom, 1 stove copper tank, 1 step ladder, 1 counter scales, 1 platform scales, 1 clock, 2 pipe vises, 4 screw-drivers, 2 mallets, 1 foot-lathe, 1 lathe dog, 1 bit-stock, 1 2-inch auger, 5 hand-saws, 1 washer cutter, 1 bench block, 1 fore-plane, 1 set of numbers, 1 directory, 8 galvanized iron pails, 2 chairs, 50 lbs. scrap leather for washers, 1 hose nozzle, 1 thermometer, 2 lbs. screws,  $\frac{1}{4}$  gallon castor oil, 5 window curtains, 1 pair of snips, 1 small plumbers' tool box, 2 hammer handles, 4 1-inch Crown meters, 4  $\frac{5}{8}$ -inch Frost meters, 1 2-inch Worthington meter, 2 2-inch Frost meters, 2  $\frac{5}{8}$ -inch Thomson meters, 1  $\frac{3}{4}$ -inch Frost meter, 5 stands for 1-inch Crown meters, 5 caps for 1-inch Crown meters, 3 caps for  $\frac{5}{8}$ -inch Crown meters, 11 tops for 1-inch Worthington meters, 11 tops for  $\frac{5}{8}$ -inch Worthington meters, 4  $1\frac{1}{2}$ -inch union brass connections for Frost meters, 7  $1\frac{1}{2}$ -inch brass solder nipples, 7 2-inch brass meter connections, 11  $1\frac{1}{2}$ -inch brass meter connections, 20  $\frac{5}{8}$ -inch brass nipples,  $\frac{1}{4}$  roll packing paper, 50  $\frac{5}{8}$ -inch brass meter unions, 6  $\frac{3}{4}$ -inch brass nipples, 2  $\frac{3}{4}$ -inch brass solder connections, 8 1-inch brass unions, 12 lead connections for Worthington meters, 1 lb. sealing wax, 1 leather tool bag, 3 pair pliers, 1 pail and tank for testing meters, 2 monkey wrenches, 6 caps for 1-inch Worthington meters, 3 sets patterns for cutting packing for Worthington meters, 16 1-inch brass unions, 24  $\frac{3}{4}$ -inch plugs, 1  $1\frac{1}{2}$ -inch tap, 1 2-inch tap.

### Property in Water Board and Superintendent's Office.

18 chairs, 5 high chairs and stools, 1 settee, 1 letter press, 7 desks with drawers, 3 standing desks with drawers, 3 office tables, 1 cabinet letter file, 2 bill cabinets, 1 bill holder, 2 book cases, 1 black wal-

nut cabinet, 1 safe, 1 clock, 3 waste baskets, 7 spittoons, 4 wrenches, 1 pick, 1 map of distributing main pipes, 1 large rubber mat, 2 grass mats, 1 water gauge, 1 pressure and recording gauge, 1 map of Lowell, 1 atlas of Lowell, 1 screw driver, 1 key rack, 1 instrument for testing capacity of engines, 1 hat rack, 1 umbrella rack, 1 water cooler, 1 feather duster, 1 typewriting machine and stand, 10 ink stands, 1 glass mug, 1 soap dish, 1 gas stove, 1 gas lamp.

#### **Tools and Property at Filter Inlet.**

2 iron tooth rakes, 2 shovels, 2 ice chisels, 1 ice rake, 2 picks, 2 stop-gate wrenches, 1 broom, 1 boat, 3 oars, 3 hoes, 1 dip net, 1 pail, 1 oil can, 1 pint lubricating oil, 1 pike pole, 1 sidewalk wrench, 1 set blocks and rope, 5 feet rubber hose, 1 step ladder.

#### **Tools and Property at Reservoir.**

2 long-handled shovels, 2 long-handled spades, 5 short-handled shovels, 2 crow bars, 3 picks, 3 scythes and snaths, 4 rakes, 1 wooden shovel, 1 iron rake, 1 scoop, 1 saw, 1 square, 1 scuff hoe, 1 hoe, 1 axe, 1 fork, 1 sod-cutter, 1 broom, 1 monkey wrench, 1 long wrench, 1 lawn mower, 1 sickle, 1 hose pipe and truck, 1 wheelbarrow, 1 hammer.

#### **Property and Tools at Pumping Station.**

1 pipe vise, 1 work bench, 1 portable forge, 8 sets braces for engine, 2 sets differential blocks, 100 feet 2-inch rope, 1 set fire irons, 1 brass hydrant, 1 axe, 11 finished wrenches, 3 hand saws, 2 jack-screws, 10 cold chisels, 2 ratchet drills, 1 socket drill, 4 caulking chisels, 1 barometer, 2 thermometers, 1 office desk, 2 indicators, 1 oil cupboard, 2 oil dishes, 1 platform scales, 4 crow bars, 64 feet  $\frac{3}{4}$ -inch iron chain, 16 eye bolts, 1 truck, 1 key-wrench for air pump, 2 iron wheelbarrows, 1 buck saw, 2 gas tongs, 2 gas lamps, 1 high-grade thermometer, 4 brass bolts, 11 wrenches for Morris engine, 11 for Worthington, 3 sledge hammers, 10 drills (assorted sizes), 5 bit-stocks, 1 25-foot ladder, 1 20-foot, 1 18-foot, 1 pair steps, 1 hoe, 2 rakes, 1 small die plate, 1 fore plane, 6 monkey wrenches, 1 piece 2-inch rope, 3 chisel bars, 4 small taps, 4 socket wrenches, 2 14-quart iron pails, 4 hand hammers, 1 grindstone, 1 anvil, 7 gas tongs, 1 hydrant wrench, 2 clocks, 1 full set dies (from 1-inch to 2-inch, right and left), 2 die-stocks and bushings, 2 sets blocks (3  $\frac{5}{8}$ -inch chains), 1 24-inch elbow, 1 scythe, 1 snath, 7 chairs, 1 office table, 2 engine lathes, 1 speed lathe, 1 upright drill, 31 turning tools, 1 12-inch chuck, 1 No. 3 drill chuck, 16 twist drills, 1 No. 2 drill chuck, 3 reamers for Desper meter, 4 small reamers, 5 lanterns.

EXTRAS—2 bench vises, 1 steel wrench, 1 meter chuck, 1 black-walnut cabinet, 1 small slide-valve engine, 2 extra twist drills, 12 lathe dogs, 10 hack-saws, 1 blow pipe, 1 hay scale, 1 furnace pot, 2 trowels, 1 tar kettle, 100 feet sheathing, 2 wood wheelbarrows, 2 pipe cutters, 9 pair 10x4-inch rubber washers, 1 set  $\frac{1}{8}$  to 1-inch reamers, 1 1x4-inch tap, 1  $\frac{1}{2}$ -inch tap, 2  $\frac{3}{8}$ -inch taps, 2 cut-nippers, 1 hand vise, 1 set figures, 4 thermometers, 3 bit-stocks, 5 hand hammers, 2 No. 2 drill chucks, 1 pipe cutter.

# ENGINEER'S REPORT.



# REPORT OF THE ENGINEER.

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OFFICE OF CITY ENGINEER,  
LOWELL, MASS., Jan. 1, 1890.

*To the Lowell Water Board:*

Gentlemen,— The following is the Seventeenth Annual Report of the work done by the pumping engines, and also the records as taken at the Beacon-street reservoir. The calculations of the duty of the engines were made from records kept by Mr. James P. Roberts, the engineer in charge at the pumping station. All the coal used for heating, pumping, and power for the repair room has been charged to pumping; no deduction has been made, and nothing added, for friction in the pump.

The largest quantity pumped during one day by both engines was 9,229,840 gallons. 130,237,790 gallons less were pumped this year than last. Probably this is partly due to the mild winter. During the year the Morris engine has run two hundred and seventy-two, and the Worthington engine seventeen nights. The cost of pumping one million gallons from the low-service reservoir to the high-service reservoir is \$9.19, which added to the average cost of raising the same quantity into the Beacon-street reservoir, makes the total cost of pumping one million gallons into the high-service reservoir, \$15.91.



**Table Showing Work Done with Morris Engine (Beam and Fly Wheel) and Boilers for each Month  
During the Year 1889.**

MONTHS.	No. of days' pump- ing.	Av. No. of hours' pump- ing per day.	Number of hours' pump- ing per month.	Number of strokes made per month.	Average No. of strokes made per minute.	Average head, including friction, in feet.	Quantity pumped per month, in U. S. gallons.	Average quantity pumped per day, in U. S. galls.	No. galls. of water raised in- to reser- voir per lb. total coal con- sumed.	Duty in lbs., 1 foot high, with 100 lbs. coal, used in pumping on- ly, no deduc- tion for ashes or clinkers.	Duty on to- tal coal con- sumed, no deduction for ashes or clinkers.
January .....	29	21-08	613-00	446,656	12.14	163.97	142,929,920	4,928,618	563	92,611,404	76,987,571
February .....	28	22-17	624-00	467,562	12.49	163.90	149,619,840	5,343,566	572	93,065,652	78,064,232
March .....	28	20-19	569-05	423,636	12.41	163.78	135,563,520	4,841,554	576	94,262,065	78,571,745
April .....	25	21-09	528-45	391,130	12.33	163.79	125,161,000	5,006,465	573	94,131,587	78,227,491
May .....	27	21-50	589-30	443,419	12.54	163.83	141,894,080	5,255,336	572	93,366,935	78,088,018
June .....	27	21-31	581-05	434,272	12.46	163.66	138,967,040	5,146,927	570	93,463,021	77,809,125
July .....	27	21-11	572-00	425,246	12.39	163.77	136,078,720	5,039,953	554	89,984,625	75,622,246
August .....	29	21-49	632-50	478,788	12.61	163.51	153,212,160	5,283,178	560	90,597,104	76,294,895
September .....	26	21-52	568-35	428,142	12.55	163.52	137,005,440	5,269,440	558	90,555,687	76,027,228
October .....	27	21-34	582-10	429,809	12.30	163.21	137,538,880	5,094,033	540	87,257,140	73,422,034
November .....	26	20-57	544-40	403,752	12.35	162.87	129,200,640	4,969,255	581	95,052,333	78,889,582
December .....	17	21-02	357-30	267,739	12.47	162.52	85,676,480	5,039,793	582	96,502,111	78,807,327
Totals and averages.	316	21-24	6,763-10	5,040,151	12.42	163.56	1,612,848,320	5,103,950	566	92,343,170	77,132,357

**Table Showing Work Done with Worthington Duplex Engine for each Month During the Year 1889.**

MONTHS.	No. of days' pump- ing.	Av. No. of hours' pumping per day.	Number of strokes made per month.	Average No. of strokes made per minute.	Average head, including friction, in feet.	Quantity pumped per month, in U. S. gallons.	Average quantity pumped per day, in U. S. galls.	No. galls. of water raised in- voir per lb. total coal con- sumed.	Duty in lbs., 1 foot high, with 100 lbs. coal, used in pumping on- ly, no deduc- tion for ashes or clinkers.	Duty on to- tal coal con- sumed, no deduction for ashes or clinkers.
January .....	3	14-30	33,589	12.87	163.91	10,412,590	3,470,863	425	67,732,718	58,056,613
February .....	..	.....	.....	.....	.....	.....	.....	...	.....	.....
March .....	..	.....	.....	.....	.....	.....	.....	...	.....	.....
April .....	..	.....	.....	.....	.....	.....	.....	...	.....	.....
May .....	..	.....	.....	.....	.....	.....	.....	...	.....	.....
June .....	2	8-15	11,233	11.35	163.08	3,482,230	1,741,115	446	76,334,333	60,676,014
July .....	4	17-37	33,569	7.94	166.28	10,406,390	2,601,597	398	67,513,781	55,125,924
August .....	..	.....	.....	.....	.....	.....	.....	...	.....	.....
September .....	..	.....	.....	.....	.....	.....	.....	...	.....	.....
October .....	..	.....	.....	.....	.....	.....	.....	...	.....	.....
November .....	..	.....	.....	.....	.....	.....	.....	...	.....	.....
December .....	12	21-09	176,307	11.58	162.36	54,655,170	4,554,597	387	59,448,824	52,375,602
Totals and averages.	21	18-18	254,698	11.05	163.40	78,956,380	3,759,828	365	62,105,171	53,851,987



**Table Showing Amount of Coal Used for Morris Engine at  
Pumping Station during the Year 1889.**

MONTHS.	COAL CONSUMED.			
	For starting fires, in lbs.	When pump- ing, in lbs.	For banking fires, in lbs.	Total per month, in lbs.
January.....	31,200	210,900	11,600	253,700
February.....	31,200	219,600	11,000	261,800
March.....	28,800	196,300	10,400	235,500
April.....	27,000	181,500	9,900	218,400
May.....	30,000	207,500	10,600	248,100
June.....	30,000	202,800	10,800	243,600
July.....	28,200	206,400	11,000	245,600
August.....	31,800	230,450	11,400	273,650
September..	28,800	206,180	10,600	245,580
October.....	29,400	214,400	11,000	254,800
November....	27,600	184,500	10,200	222,300
December....	18,600	120,250	8,400	147,250
Totals.....	342,600	2,380,780	126,900	2,850,280

**Table Showing Amount of Coal Used for Worthington Du-  
plex Engine at Pumping Station during the Year 1889.**

MONTHS.	COAL CONSUMED.			
	For starting fires, in lbs.	When pump- ing, in lbs.	For banking fires, in lbs.	Total per month, in lbs.
January.....	2,700	21,000	800	24,500
February.....	.....	.....	.....	.....
March.....	.....	.....	.....	.....
April.....	.....	.....	.....	.....
May.....	.....	.....	.....	.....
June.....	1,200	6,200	400	7,800
July.....	3,600	21,360	1,200	26,160
August.....	.....	.....	.....	.....
September..	.....	.....	.....	.....
October.....	.....	.....	.....	.....
November....	.....	.....	.....	.....
December....	12,600	124,400	4,200	141,200
Totals.....	20,100	172,960	6,600	199,660

**Table Showing Work Done with Worthington High-Service Engine for each Month during the Year 1889.**

MONTHS.	No. of days' pumping.	Av. No. of hours' pumping per day.	Number of hours' pumping per month.	Number of strokes made per month.	Av. No. of strokes made per minute.	Av. head, including friction, in feet.	Quantity pumped per month, in U. S. gallons.	Av. quantity pumped per day, in U. S. gallons.	No. gals. water pumped into reser. voir per lb. of total coal consumed.	Coal, in lbs., used when pumping.
January .....	5	16-11	80-55	173,913	35.82	78.67	2,434,782	486,956	319	7,640
February .....	4	14-56	59-45	132,061	36.84	78.67	1,848,854	462,213	319	5,800
March .....	4	14-34	58-15	126,920	36.31	78.67	1,776,880	444,220	320	5,550
April .....	5	11-34	57-50	120,930	34.85	78.67	1,692,880	338,576	300	5,640
May .....	5	16-52	84-20	170,695	33.73	78.67	2,389,730	477,946	321	7,440
June .....	4	13-49	55-15	116,453	35.13	78.67	1,630,342	407,585	326	5,000
July .....	4	17-30	70-00	145,909	34.74	78.67	2,042,726	510,681	300	6,800
August .....	5	15-28	77-20	160,199	34.53	78.67	2,242,786	448,557	301	7,440
September .....	4	13-49	55-15	121,349	36.61	78.67	1,698,886	424,721	300	5,680
October .....	5	10-20	51-40	124,370	40.12	78.67	1,741,180	348,236	304	5,780
November .....	4	10-00	40-00	83,066	34.61	78.67	1,162,924	290,731	319	3,640
December .....	4	13-42	54-50	120,025	36.48	78.67	1,680,350	420,087	311	5,400
Totals and averages..	53	14-04	745-25	1,595,880	35.68	78.67	22,342,320	421,553	311	71,740

## PUMPING STATION, MORRIS ENGINE.

## RUNNING EXPENSES FOR THE YEAR 1889.

Pay of engineers and firemen.....	\$3,994 57
766 $\frac{770}{2000}$ tons coal (Pocahontas, 1888 and 1889), @ \$4.241,	3,250 24
24 $\frac{345}{2000}$ tons coal (Cumberland, 1889), @ \$4.241.....	104 36
634 $\frac{325}{2000}$ tons coal (Cumberland, 1889), @ \$4.366.....	2,768 69
Gas for lighting works.....	87 56
Electric light.....	147 76
179.70 gallons cylinder oil, @ 50 cents.....	89 85
190.73 gallons machine oil, @ 25 cents.....	47 68
1 gallon lard oil, @ 80 cents.....	80
158.25 pounds cotton waste, @ 11 $\frac{1}{4}$ cents.....	18 59
41.95 pounds Eureka packing, @ 60 cents.....	25 17
24.62 pounds flax packing, @ 32 $\frac{3}{4}$ cents.....	8 04
9.25 pounds rubber packing, @ 30 cents.....	2 78
0.75 of a pound of Empire packing.....	26
Repairs on engine.....	11 22
Repairs on boilers.....	14 39
Recording gauge (proportional cost).....	71 50
Tools and stock.....	45 42
Sundries.....	22 91
Total,.....	<u>\$10,711 79</u>

Cost of pumping water into reservoir per million gallons, \$6 64

Cost of pumping water one foot high per million gallons, 04 $\frac{8}{100}$

## PUMPING STATION, WORTHINGTON ENGINE.

## RUNNING EXPENSES FOR THE YEAR 1889.

Pay of engineers and firemen.....	\$195 68
16 $\frac{300}{2000}$ tons coal (Pocahontas, 1888 and 1889), @ \$4.241.	68 49
83 $\frac{160}{2000}$ tons coal (Cumberland, 1889), @ \$4.366.....	365 35
Gas for lighting works.....	4 29
Electric light.....	7 24
8.80 gallons cylinder oil, @ 50 cents.....	4 40
9.36 gallons machine oil, @ 25 cents.....	2 34
Amount carried forward.....	<u>\$647 79</u>

<i>Amount brought forward</i> .....	\$647 79
7.75 pounds cotton waste, @ 11 $\frac{3}{4}$ cents.....	91
2.05 pounds Eureka packing, @ 60 cents.....	1 23
12 $\frac{3}{4}$ pounds hemp packing, @ 25 cents.....	3 19
Repairs on engine.....	2 36
Repairs on boilers.....	70
Recording gauge (proportional cost).....	3 50
Tools and stock.....	2 23
Sundries .....	1 12
<b>Total</b> .....	<b>\$668 03</b>
Cost of pumping water into reservoir per million gallons,	\$8 40
Cost of pumping water one foot high per million gallons,	05 $\frac{14}{100}$

The following table shows the average depth of water, the number of gallons, and the temperature of the water in the Beacon-street reservoir, and also the temperature of the air, for each month in 1889. The temperature of the water was taken at 6 A. M. and 6 P. M., and of the air at 6 A. M., 1 P. M., and 6 P. M.

MONTHS.	Depth in Feet.	Quantity, in U. S. Gallons.	Temperature in Degrees.	
			Of Water.	Of Air.
January.....	19.50	29,673,275	37.54	31.93
February.....	18.96	28,761,955	36.50	23.51
March .....	19.44	29,578,108	38.31	37.45
April .....	19.12	29,037,654	49.16	50.14
May .....	19.01	28,845,430	62.83	65.62
June .....	19.19	29,158,966	69.08	72.71
July .....	18.59	28,148,478	72.98	73.59
August .....	19.09	28,977,718	70.38	70.06
September.....	19.00	28,825,944	66.84	65.79
October .....	19.22	29,202,219	50.45	48.68
November.....	19.04	28,905,305	43.26	44.42
December .....	19.04	28,899,736	34.80	35.19



Table showing the average monthly and daily consumption of water for the year 1889 :

MONTHS.	Gallons per month.	Gallons per day.
January.....	151,587,437	4,889,917
February.....	153,863,694	5,495,132
March.....	134,670,036	4,344,194
April.....	124,192,768	4,139,759
May.....	140,006,171	4,516,328
June.....	142,167,399	4,738,913
July.....	152,489,246	4,919,008
August.....	147,841,458	4,769,079
September.....	140,061,162	4,668,705
October.....	134,833,805	4,349,478
November.....	128,004,801	4,266,827
December.....	141,387,328	4,560,882
Total and averages.....	1,691,105,305	4,633,165

#### WATER ANALYSES.

Samples of water were taken about the middle of each month from center of Merrimack River, opposite the filtering basin, filtering gallery chamber, Bodwell gate-house, at the end of the brick conduit, and the Beacon-street reservoir, until June, and since then only one sample has been taken from Merrimack River opposite the filtering basin. These samples have been sent to the State Board of Health, and the result of the analyses will be given in their report.

Respectfully submitted,

GEO. E. EVANS,

*City Engineer.*

# REPORT ON FILTRATION.

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# REPORT ON FILTRATION.

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BY J. ARTHUR GAGE, A. M., M. D.

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## *To Lowell Water Board:*

Gentlemen,—In discussing filtration, it may be well to look first at that which we wish to remove, and why we attempt to remove it, in order that we may more accurately estimate the value of any methods that might be employed. The impurities in water consist, first, of chemical impurities; secondly, of living organisms (including Algæ, and the so-called “Germs,” or “Bacteria”). The first class was discussed in last year’s report; its presence in Merrimack-river water noted, and the necessity of its removal urged. The Algæ are mostly found in ponds and need not be discussed here. The “Germs” deserve further mention. For our purpose, they may be divided into two general classes, the Saprophytic (non-disease-producing), and the Pathogenic (disease-producing). The first class comprises most of the germs found in water, and they are called non-disease-producing because they do not produce a *definite* disease in the human system. Nevertheless, they are believed to be injurious and capable of causing diarrhœal and other disturbances of the digestive tract, when taken into the system. This class includes a great variety of species and kinds, about which little is yet known, except that they occur in varying frequency in different waters, and that water containing them is proportionately unfit for drinking purposes. The frequency with which they occur may be estimated from the following figures. In spring water at its source, few or none are found, when the

spring comes from a gravelly or rocky bed. In some well waters 75 to 100 germs to one c.c. of water are found. In an average of many experiments in Berlin, 200 germs to one c.c. of water were found. In the Potomac River, 300 were found when the water was clear, and these increased to 3000 when the water was turbid. In every case, the number of the Bacteria grew *pari passu* with the turbidity of the water. (If this be true of our river, we shall have to be suspicious of the turbidity that has formerly been considered, in itself, harmless). In the case of a common sink filter, after a month's use, water drawn through it contained 171,000 germs to one c.c. of water.

The second class (Pathogenic) includes, as far as is at present known, the Cholera Germ, the Typhoid Bacillus, and the Germ causing suppuration. The Typhoid Germ chiefly interests us on account of the liability of its being present in any river water receiving sewage. The experience of Providence, where Typhoid Germs from the dejections of persons sick with the disease, further up the river, being washed into the river, caused an epidemic in the city of Providence, R. I., is too well known to need repetition here.

The Typhoid Germ can retain its vitality in water for twenty days. In the presence of sewage, it will multiply and grow for three or four days; and it will do the same in milk, even if it be sterilized. Heat favors its development. The method by which these different germs are taken from the water and counted, is as follows: Draw 50 c.c. of water into a *S* (sterilized) flask; take 1 c.c. in a *S* pipette or glass tube, and mix it with 10 c.c. of *S*, warm, nutrient gelatine. This is then flowed on to a *S* glass plate, over ice, to harden the gelatine, and placed under a bell jar. This is called a plate culture, and is placed in a *S* chamber with moisture, and a temperature of 70° F., and left from 48 to 72 hours. Each germ in the original 1 c.c. of water feeds upon the gelatine and produces others, till around each germ there is a colony of its descendants. These can be seen under microscope as little specks in the gelatine and are counted. Then, from the proportion of water to gelatine, can be reckoned the number of germs in the original

1 c.c. of water. The Typhoid Bacillus is grown in a similar manner on *S* potatoes, and can be colored and detected by its shape, size, and appearance.

In selecting a water for drinking purposes, it is desirable to procure one where there is no contamination by chemical or living impurities. But where these are present, it becomes an important question how to get rid of them. This has been recognized in commercial circles, and householders have been urged to buy a variety of tap-filters, warranted to purify (?) the water. Recent experiments (Swarts), go to show the contrary. Seven different sink (or tap) filters were used, and the water flowing through these compared with the water from an open tap. For a few days, the filters removed some of the germs; but after seventeen days, all showed an increase of the number of germs, although some of the filters were claimed to be self-purifying by washing out. The original water supply contained thirty-six colonies of germs to one c.c. of water, while that of the filters varied from 2000 to 6000, the highest having 171,000. The filters simply caught the germs (and chemical poisons on which they feed), and allowed them to develop in the warm atmosphere of the room, only to be washed through later by the water and drunk by the individual. Filtration by this method, therefore, is positively dangerous and should be abandoned.

The subject of filtration is being studied by the State Board of Health, and though the results are not complete, they furnish an indication of the solution of the problem. As a result of the State authorities' experiments at Lawrence, Mass., the State Board finds that at the rate of 300,000 gallons of water to one acre of land (filter-bed 5 1-2 feet deep), about three-fourths of the ammonias are removed, nearly all the Algæ, and three-quarters of the Bacteria. The filtration was intermittent, and the temperature and length of time in use modified the result. After some months the impurities stored in the filter were washed through.

The color of the water was also much improved. When applying larger quantities of water, the results were not so good.

Experiments with sewage showed that, under favorable conditions, almost all the living organisms can be removed from water.

In further experiments made with Brockton water, rapid, continuous filtration was used, and the filter-bed washed at intervals. A small percentage of the impurities were removed, but the Board do not consider the results sufficiently satisfactory to recommend this method. With the use of alum, better results were obtained, but the use of this agent in drinking water is, I believe, indefensible.

The artificial filters that I have been able to examine, would, I believe, fail to fully meet the requirements for the following reasons: A large quantity of water is forced under considerable pressure through a relatively very small portion of filter-sand continuously, and, in one case, without access of air. Under such conditions, I do not believe any large percentage of the impurities would be removed. Certainly nitrification could not go on. The samples of Croton water filtered through one of these filters supports this opinion. As witness:

**Analysis Croton Water.**

PARTS 100,000.

	Total Residue.	Loss on Ignit.	Free Ammonia.	Alb. Ammonia.	Chlorine.
Before filtration.....	8.5	2.0	0.0032	0.0140	0.12
After filtration.....	8.4	1.2	0.0032	0.0104	0.11

Such a result would be inadequate, if applied to Lowell water.

Agents of the filter companies furnish statements made by chemical experts, to the effect that their filters remove nearly all the germs from water, but the amount filtered and the rate of filtration are not stated. It is highly improbable that these filters, differing only in mechanical construction from the experimental filters used by the State Board, will give any different results, or remove any more germs.

It is also difficult to see how the germs caught in the filter-bed can be washed out again, when the water, *under the same pressure*, is merely forced in the opposite direction; and it is possible that such a filter might, like the sink filters, only on a larger scale, retain the germs and allow them to increase, to further contaminate the water, unless the filter-bed was frequently replaced by fresh sand.

I must conclude, therefore, that the *mechanical filters* so far examined do not furnish a reasonable expectation of satisfactorily doing the work.

I remain respectfully,

J. ARTHUR GAGE.

Lowell, Mass., Jan. 2, 1890.



## APPENDIX.





# ANALYSES OF WATER.

[Published from advanced sheets of Annual Report of Massachusetts State Board of Health, through courtesy of Henry P. Walcott, M. D., Chairman.]

**Chemical Examination of Water from the Merrimack River above Lowell, opposite the Inlet to the Lowell Water Works.**

[Parts per 100,000.]

Number.	DATE OF		APPEARANCE.			RESIDUE ON EVAPORATION.			AMMONIA.		NITRO-GEN AS		
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albumi- noid.	Chlorine.	Nitrates.	Nitrites.
108	June 14	June 15	Slight.	Very slight.	0.40	3.90	1.55	2.35	.0020	.0122	.16	.0130	.....
332	July 14	July 15	Very slight.	Slight.	0.40	3.55	1.15	2.40	.0010	.0133	.12	.0030	.....
576	Aug. 18	Aug. 19	Very slight.	Very slight.	0.00	4.07	1.15	2.92	.0027	.0177	.14	.0070	.....
782	Sept. 15	Sept. 16	Slight.	Slight.	0.15	3.95	0.80	3.15	.0018	.0148	.20	.0070	.....
908	Oct. 30	Oct. 31	Very slight.	Very slight.	0.40	3.85	0.70	3.15	.0042	.0152	.19	.0080	.....
1209	Nov. 17	Nov. 18	Decided.	Con., earthy and floc't.	0.75	5.15	1.25	3.90	.0028	.0203	.24	.0090	.....
1415	Dec. 15	Dec. 16	Decided.	Considerable, earthy	0.40	5.60	1.50	4.10	.0007	.0169	.15	.0120	.....
1844	Jan. 19	Jan. 21	Very slight.	Very slight.	0.30	3.95	1.00	2.95	.0016	.0116	.13	.0200	.0001
1848	Feb. 16	Feb. 17	Slight.	Very slight.	0.35	3.90	0.95	2.95	.0046	.0150	.19	.0180	.0000
2020	Mar. 15	Mar. 16	Slight.	Very slight.	0.20	3.65	0.90	2.75	.0031	.0122	.21	.0080	.0002
2263	Apr. 19	Apr. 20	Distinct.	Con., earthy and floc't.	0.25	6.30	0.70	5.60	.0000	.0116	.16	.0100	.0003
2450	May 17	May 18	Decided.	Much, earthy.	0.25	13.15	1.10	12.05	.0000	.0154	.09	.0030	.0001
2603	June 14	June 15	Very slight.	Slight, earthy and floc't.	0.35	3.55	0.95	2.60	.0020	.0162	.16	.0100	.0003
2809	July 19	July 23	Very slight.	Very slight.	0.10	3.20	0.55	2.65	.0014	.0142	.19	.0050	.0001
2968	Aug. 16	Aug. 17	Slight.	Slight.	0.20	3.95	0.85	3.10	.0026	.0140	.22	.0070	.0002
2969	Aug. 16	Aug. 17	Slight.	Slight.	0.25	3.75	0.90	2.85	.0022	.0158	.22	.0080	.0003
2990	Aug. 16	Aug. 17	Slight.	Slight.	0.15	3.90	0.65	3.25	.0018	.0180	.22	.0070	.0002
3228	Sept. 20	Sept. 21	Slight.	Slight, earthy.	0.30	3.60	1.05	2.55	.0026	.0186	.16	.0080	.0005
3229	Sept. 20	Sept. 21	Slight.	Slight, earthy.	0.30	3.55	1.35	2.20	.0028	.0174	.15	.0030	.0004
3397	Oct. 18	Oct. 19	Slight.	Slight.	0.50	3.35	1.25	2.10	.0004	.0164	.11	.0070	.0002
3398	Oct. 18	Oct. 19	Slight.	Slight.	0.50	3.50	1.25	2.25	.0000	.0176	.13	.0080	.0003

## Examination of Water Opposite the Inlet (continued).

Number.	DATE OF		APPEARANCE.			RESIDUE ON EVAPORATION.			AMMONIA.		NITROGEN AS		
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albumi- noid.	Chlorine.	Nitrates.	Nitrites.
3556	Nov. 15	Nov. 16	Slight.	Slight, earthy.	0.50	3.20	1.30	1.90	.0002	.0152	.10	.0150	.0002
	18 89									.0122			
3874	Jan. 17	Jan. 19	Slight, milky.	Considerable, earthy	0.15	2.75	0.50	2.25	.0000	.0100	.12	.0050	.0004
	18 89									.0100			
4084	Feb. 21	Feb. 23	Slight.	Slight.	0.20	3.20	1.00	2.20	.0008	.0108	.16	.0180	.0004
										.0090			
4368	Mar. 21	Mar. 22	Distinct, milky.	Considerable, earthy	0.20	2.85	1.00	1.85	.0000	.0150	.09	.0030	.0003
										.0114			
4536	Apr. 18	Apr. 19	Slight.	Considerable, earthy	0.20	2.70	0.75	1.95	.0002	.0130	.08	.0020	.0002
										.0112			
4690	May 18	May 20	Slight.	Con., earthy and floe't.	0.20	3.25	0.95	2.30	.0032	.0156	.15	.0050	.0002
										.0138			
AV.	.....	.....	.....	.....	0.32	5.09	1.06	4.03	.0016	.0147	.15	.0087	.0002

Hardness in May, 1888, 0.6. Odor, very faintly vegetable, often none, occasionally mouldy. The samples were collected from the river opposite the inlet to the Lowell Water Works one foot beneath the surface. Nos. 2958 and 2959 were collected from all parts of the width of the river, No. 2958 being collected in the north half of the river, and No. 2959 being collected in the south half. No. 3228 was from the middle of the north half of the river, and No. 3229 from the middle of the south half. No. 3397 was from the north half of the river, and No. 3396 from the south half of the river.

## Continuation of Above.

Number.	DATE OF		APPEARANCE.			RESIDUE ON EVAPORATION.			AMMONIA.		NITROGEN AS		
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albumi- noid.	Chlorine.	Nitrates.	Nitrites.
4803	June 18	June 20	Distinct.	Con., earthy and floe't.	0.25	.....	.....	.....	.0032	.0156	...	.0060	.0001
	18 89									.0154			
4944	July 16	July 17	Very slight.	Slight.	0.25	.....	.....	.....	.0032	.0168	...	.0080	.0002
										.0148			
5057	Aug. 13	Aug. 14	Very slight.	Considerable.	0.3	.....	.....	.....	.0034	.0192	.14	.0030	.0002
										.0148			
5160	Sept. 10	Sept. 11	Very slight.	Slight, earthy.	0.2	.....	.....	.....	.0036	.0156	.18	.0120	.0001
										.0128			
5251	Oct. 14	Oct. 15	Slight.	Slight.	0.7	.....	.....	.....	.0025	.0196	.18	.0030	.0001
										.0166			
5355	Nov. 18	Nov. 19	Very slight.	Very slight.	0.5	.....	.....	.....	.0008	.0126	.17	.0080	.0001
										.0112			
5463	Dec. 17	Dec. 19	Very slight.	Sl't, earthy and floe't.	0.2	.....	.....	.....	.0000	.0148	.14	.0120	.0001
										.0100			
5532	Jan. 14	Jan. 16	Very slight, milky.	Very slight.	0.2	.....	.....	.....	.0010	.0074	.15	.0120	.0001
	18 90									.0056			

**Microscopical Examination.**

	1888.											1889.				
	June.	July.	Aug.	Aug.	Aug.	Sept.	Sept.	Oct.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algae.....	pr.	0.0	pr.	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.
2. Other Algae.....	4.2	0.9	2.4	5.7	4.3	1.8	2.6	pr.	0.5	1.7	0.2	0.3	0.2	0.5	0.9	0.3
3. Fungi.....	0.1	0.1	0.0	0.0	pr.	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms.....	0.0	0.1	pr.	0.2	0.2	pr.	0.1	0.0	0.0	0.0	pr.	0.0	pr.	pr.	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus*; Zoosporeæ, *Scenedesmus*; Desmidiaceæ; Diatomaceæ, *Synedra*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa; Rotifera.

**Chemical Examination of Water from the Merrimack River above Lowell at the Inlet to the Lowell Water Works.**

[Parts per 100,000.]

Number.	DATE OF		APPEARANCE.			RESIDUE ON EVAPORATION.			AMMONIA.		Chlorine.	NITROGEN AS	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albumi. noid.		Nitrates.	Nitrites.
104	18 87 June 14	June 15	Decided.	Consid'ble, brown.	0.30 4.20	1.50	2.70	.0019	.0119		.24	.0130	.....
333	July 14	July 15	Very slight.	Very slight.	0.40 3.90	1.35	2.55	.0025	.0151		.14	.0070	.....
577	Aug. 18	Aug. 19	Decided.	Slight, red-dish brown.	0.50 5.62	0.85	4.77	.0129	.0131		.19	.0260	.....
783	Sept. 15	Sept. 16	Slight.	Slight.	0.15 4.10	1.00	3.10	.0030	.0160		.21	.0070	.....
1000	Oct. 20	Oct. 21	Very slight.	Very slight.	0.25 4.10	0.85	3.25	.0035	.0136		.21	.0080	.....
1211	Nov. 17	Nov. 18	Decided.	Con., earthy and floe't.	0.75 5.35	1.05	4.30	.0026	.0246		.26	.0100	.....
1417	Dec. 15	Dec. 16	Decided.	Con., earthy and floe't.	0.40 5.60	1.30	4.30	.0016	.0167		.18	.0100	.....
1645	18 88 Jan. 19	Jan. 21	Slight.	Slight.	0.25 3.80	0.85	2.95	.0012	.0120		.14	.0200	.0001
1849	Feb. 16	Feb. 17	Slight.	Very slight.	0.35 3.70	0.75	2.95	.0056	.0157		.18	.0150	.0000
2022	Mar. 15	Mar. 16	Distinct.	Very slight.	0.20 3.65	0.85	2.80	.0034	.0106		.17	.0100	.0001
2265	Apr. 19	Apr. 20	Decided.	Much, brown.	0.35 7.15 2.90 0.80 2.10	0.80	6.35	.0022	.0126		.14	.0200	.0002
2451	May 17	May 18	Decided.	Much, earthy.	0.30 12.15 2.85 1.65 1.20	1.30	10.85	.0004	.0188 .0110		.11	.0080	.0000
2604	June 14	June 15	Slight.	Sli't, earthy and floe't.	0.30 3.70 0.80 2.90			.0056	.0142 .0124		.11	.0150	.0001
2810	July 19	July 21	Slight.	Sli't, earthy and floe't.	0.10 3.40 0.70 2.70			.0024	.0170 .0116		.18	.0050	.0002
Av.	.....	.....	.....	.....	0.33 5.28	1.04	4.24	.0035	.0151		.18	.0124	.0001

Hardness in May, 1888, 0.6. Odor, very faintly vegetable, often none, occasionally mouldy. The samples were collected in the inlet chamber where water comes in direct from the river and before it mingles with water from the filter-gallery or filter-inlet.

## Microscopical Examination.

	1888.		
	May.	June.	July.
1. Blue-green Algae.....	0.0	0.0	0.0
2. Other Algae.....	pr.	2.5	7.9
3. Fungi.....	0.0	pr.	2.0
4. Animal Forms.....	0.0	0.1	0.1

Groups and principal genera of organisms observed: 2. Palmellaceæ, *Chlorococcus*; Zoosporeæ, *Tetraspora*; Desmidiaceæ; Diatomaceæ, *Synedra*, *Tabellaria*. 3. Schizomycetes, *Crenothrix*. 4. Protozoa; Rotifera; Entomostraca.

## Chemical Examination of Water from Conduit at Bodwell Gate-house.

[Parts per 100,000.]

Number.	DATE OF		APPEARANCE.			RESIDUE ON EVAPORATION.			AMMONIA.		Chlorine.	NITROGEN AS	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	<b>18 87</b>												
106	June 14	June 15	Slight.	Sl't, brown.	0.50	4.02	1.50	2.52	.0020	.0107	.17	.0060	.....
334	July 14	July 15	Very slight.	Slight.	0.40	3.65	1.25	2.40	.0020	.0136	.16	.0070	.....
579	Aug. 18	Aug. 19	Very slight.	Slight.	0.60	4.55	0.97	3.58	.0029	.0197	.19	.0130	.....
785	Sept. 15	Sept. 16	Slight.	Sl't, earthy.	0.20	4.56	0.85	3.65	.0038	.0144	.21	.0130	.....
1212	Nov. 17	Nov. 18	Decided.	Con., earthy and floe't.	0.75	5.25	1.45	3.80	.0038	.0206	.25	.0100	.....
1418	Dec. 15	Dec. 16	Decided.	Consid'ble, earthy.	0.40	5.40	1.25	4.15	.0031	.0171	.17	.0180	.....
	<b>18 88</b>												
1646	Jan. 19	Jan. 21	Slight.	Sl't, earthy.	0.20	3.95	1.05	2.90	.0024	.0116	.13	.0250	.0001
1847	Feb. 16	Feb. 17	Slight.	Very slight.	0.35	3.95	0.95	3.00	.0056	.0140	.18	.0200	.0000
2023	Mar. 15	Mar. 16	Distinct.	Very slight.	0.20	3.95	0.95	3.00	.0047	.0116	.18	.0200	.0001
2266	Apr. 19	Apr. 20	Distinct.	Sl't, brown.	0.30	3.85	1.10	2.75	.0020	.0113	.18	.0300	.0002
2452	May 17	May 18	Decided.	Slight, earthy.	0.30	6.05	0.95	5.10	.0022	.0144 .0098	.13	.0180	.0001
2811	July 19	July 21	Slight.	Sl't, earthy and floe't.	0.15				.0030	.0142 .0096	.19	.0200	.0001
2907	Aug. 17	Aug. 18	Slight.	Slight.	0.25				.0050	.0154 .0116	.20	.0200	.0001
3232	Sept. 20	Sept. 21	Very slight.	Slight.	0.30				.0036	.0140 .0138	.18	.0120	.0013
3398	Oct. 18	Oct. 19	Distinct.	Slight, green.	0.60				.0026	.0130 .0124	.18	.0250	.0004
3558	Nov. 15	Nov. 16	Slight.	Slight, earthy.	0.45				.0040	.0118 .0118	.17	.0250	.0002
3787	Dec. 20	Dec. 22	Decided.	Consid'ble, earthy.	0.35				.0000	.0166 .0118	.11	.0150	.0004

**Examination of Water from Conduit (continued).**

Number.	DATE OF		APPEARANCE.			RESIDUE ON EVAPORATON.			AMMONIA.		NITRO-GEN AS		
	Collection.	Examina- tion.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albumi- noid.	Chlorine.	Nitrates.	Nitrites.
3871	Jan. 17	18 89 Jan. 19	Slight, milky.	Considera- ble, earthy	0.15	3.35	1.00	2.35	.0028	.0134 .0098	.16	.0180	.0004
4086	Feb. 21	Feb. 23	Distinct.	Slight.	0.20	3.60	1.00	2.60	.0032	.0112 .0094	.20	.0300	.0004
4371	Mar. 21	Mar. 22	Distinct, milky.	Slight, earthy.	0.20	3.15	0.65	2.50	.0020	.0132 .0100	.13	.0040	.0003
4538	Apr. 18	Apr. 19	Slight.	Slight, earthy.	0.25	3.25	1.00	2.25	.0036	.0132 .0106	.13	.0150	.0002
4692	May 18	May 20	Distinct.	Con., earthy and floct.	0.25	3.65	1.20	2.45	.0064	.0166 .0146	.16	.0100	.0002
Av.	.....	.....	.....	.....	0.33	4.47	1.12	3.35	.0032	.0142	.17	.0170	.0003

Hardness in May, 1888, 1.1. Odor, very faintly vegetable, often none, occasionally mouldy. The samples were collected from the conduit at the Bodwell gate-house. These samples are river water mixed with the water which comes from the filter-gallery, and show the quality of the water before it is pumped to the distributing reservoirs. The filter-inlet was cleaned July 14, 1888. The filter-gallery was cleaned soon after May 17, 1888.

**Microscopical Examination.**

	1888.						1889.				
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ.....	0.1	0.0	0.0	0.0	0.0	.....	0.0	0.0	0.0	pr.	0.0
2. Other Algæ.....	2.5	1.3	0.7	0.4	0.2	.....	1.7	0.4	0.8	1.5	0.8
3. Fungi.....	0.4	0.3	0.0	0.0	0.0	.....	0.0	0.0	0.0	0.0	0.0
4. Animal Forms.....	pr.	pr.	pr.	0.0	0.0	.....	0.1	0.0	pr.	pr.	0.0

Groups and principal genera of organisms observed: 1, Cyanophyceæ. 2, Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira*, *Synedra*. 3, Schizomycetes. 4, Protozoa.



**Chemical Examination of Water from Low-Service Distributing Reservoir.**  
[Parts per 100,000.]

Number.	DATE OF		APPEARANCE.			RESIDUE ON EVAPORATION.			AMMONIA.		NITROGEN AS		
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
<b>18 87</b>													
105	June 14	June 15	Decided.	Very slight.	0.30	3.70	1.07	2.63	.0002	.0125	.17	.0150	.....
335	July 14	July 15	None.	Very slight.	0.40	3.92	1.05	2.87	.0013	.0152	.16	.0130	.....
578	Aug. 18	Aug. 19	Very slight.	Very slight.	0.60	4.35	1.25	3.10	.0025	.0195	.13	.0130	.....
784	Sept. 15	Sept. 16	Slight.	Sl't, earthy.	0.20	4.40	1.35	3.05	.0020	.0152	.22	.0260	.....
1002	Oct. 20	Oct. 21	Slight.	Con., e'rthy.	0.30	4.60	0.80	3.80	.0026	.0163	.24	.0200	.....
1213	Nov. 19	Nov. 21	Slight.	Slight.	0.40	4.45	1.20	3.25	.0042	.0189	.24	.0180	.....
1419	Dec. 15	Dec. 16	Distinct.	Very slight.	0.40	5.00	1.10	3.90	.0060	.0138	.22	.0200	.....
<b>18 88</b>													
1647	Jan. 19	Jan. 21	Slight.	Sl't, earthy.	0.30	3.95	1.00	2.95	.0026	.0120	.17	.0250	.0001
1846	Feb. 16	Feb. 17	Slight.	Slight.	0.35	3.85	0.95	2.90	.0062	.0151	.19	.0200	.0000
2024	Mar. 15	Mar. 16	Distinct.	Slight.	0.25	3.95	1.25	2.70	.0041	.0160	.18	.0200	.0001
2267	Apr. 19	Apr. 20	Distinct.	Very slight.	0.10	3.50	0.95	2.55	.0038	.0124	.18	.0300	.0002
2453	May 17	May 18	Decided.	Sl't, earthy.	0.20	<b>3.25</b>	<b>1.15</b>	<b>2.10</b>	.0018	.0130	.12	.0200	.0001
										<b>.0086</b>			
2605	June 14	June 15	Distinct.	Sl't, earthy and floe't.	0.30	<b>3.50</b>	<b>1.10</b>	<b>2.40</b>	.0006	.0142	.17	.0200	.0001
										<b>.0124</b>			
2812	July 19	July 21	Very slight.	Sl't, earthy and floe't.	0.15	<b>3.90</b>	<b>0.85</b>	<b>3.05</b>	.0030	.0128	.20	.0200	.0001
										<b>.0112</b>			
2968	Aug. 17	Aug. 18	Slight.	Sl't, brown.	0.15	<b>3.85</b>	<b>1.05</b>	<b>2.80</b>	.0020	.0148	.21	.0100	.0001
										<b>.0120</b>			
3233	Sept. 20	Sept. 21	Slight.	Slight.	0.20	<b>3.80</b>	<b>0.85</b>	<b>2.95</b>	.0022	.0140	.19	.0080	.0000
										<b>.0126</b>			
3399	Oct. 18	Oct. 19	Distinct.	Sl't, green.	0.60	<b>4.20</b>	<b>1.35</b>	<b>2.85</b>	.0030	.0142	.17	.0250	.0003
										<b>.0124</b>			
3560	Nov. 15	Nov. 16	Slight.	Sl't, brown.	0.40	<b>3.75</b>	<b>1.10</b>	<b>2.65</b>	.0024	.0140	.17	.0280	.0003
										<b>.0114</b>			
3786	Dec. 20	Dec. 22	Distinct.	Con., floe't.	0.25	<b>3.70</b>	<b>0.75</b>	<b>2.95</b>	.0032	.0124	.19	.0080	.0003
										<b>.0096</b>			
<b>18 89</b>													
3873	Jan. 17	Jan. 19	Sl't, milky.	Sl't, earthy.	0.15	<b>3.60</b>	<b>0.95</b>	<b>2.65</b>	.0028	.0098	.17	.0080	.0003
										<b>.0084</b>			
4087	Feb. 21	Feb. 23	Very slight.	Consid'ble.	0.15	<b>3.40</b>	<b>1.05</b>	<b>2.35</b>	.0034	.0114	.16	.0300	.0004
										<b>.0080</b>			
4370	Mar. 21	Mar. 22	Distinct, milky.	Sl't, earthy and floe't.	0.20	<b>3.20</b>	<b>1.00</b>	<b>2.20</b>	.0030	.0124	.14	.0050	.0003
										<b>.0094</b>			
4539	Apr. 18	Apr. 19	Slight.	Sl't, earthy.	0.25	<b>3.10</b>	<b>1.00</b>	<b>2.10</b>	.0018	.0134	.12	.0100	.0002
										<b>.0106</b>			
4693	May 18	May 20	Distinct.	Consid'ble.	0.15	<b>3.40</b>	<b>1.05</b>	<b>2.35</b>	.0026	.0144	.15	.0120	.0001
										<b>.0110</b>			
AV.	.....	.....	.....	.....	0.28	4.15	1.09	3.06	.0028	.0139	.18	.0177	.0002

Hardness in May, 1888, 1.1. Odor, very faintly vegetable, often none, occasionally mouldy. The samples were collected from the outlet of the reservoir where the water flows into the distributing pipes.



**Microscopical Examination.**

	1888.								1889.				
	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ.....	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ.....	pr.	4.7	pr.	2.8	0.7	pr.	0.0	0.7	1.2	pr.	0.5	0.4	0.1
3. Fungi.....	0.0	0.8	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.
4. Animal Forms.....	0.0	0.3	pr.	pr.	pr.	pr.	0.0	0.0	0.0	0.0	0.1	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophycæ. 2. Palmellacæ, *Chlorococcus*; Zoosporeæ; Desmidiacæ; Diatomacæ, *Synedra*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa; Spongiaria; Entomostraca.







